

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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Number 3



STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
 San Francisco, California

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SARDINE OIL AND OUR TROUBLED WATERS¹

By W. L. SCOFIELD

*California State Fisheries Laboratory
Division of Fish and Game*

Our sardine fishery in California has had a short, spectacular and tragic career. In the few years since the start of the World War, it has risen from insignificance to a place among the leading fisheries of the world and it now is facing a crisis. Our management of this fishery during the next few years will determine whether this career is to be a skyrocket that will drop back into darkness after a brief burst of glory, or whether it will be made a genuine career that will bring continuous wealth and satisfaction to the people of the State for years into the future. The fishery can be abandoned as a worked-out mine or it can be treated as a farm to produce a rich annual crop continuously. The fishery in its brief existence has produced many millions of dollars, and, if abandoned, this source of wealth to the people of the State will be canceled. If managed as a farm on the basis of sustained yield, the continuous crop will be worth several millions of dollars each year indefinitely into the future. There can be no question as to which procedure will yield the greatest total return and utilize this great resource most profitably. The question is whether we can recognize the crisis and apply common sense to the problem before it is too late.

The sardine is our problem child with great possibilities for good or harm, according to the way it is handled. It has one quality that can not be ignored, and the near future will determine whether it is a curse or a blessing. The sardine is rich in oil. The oil can be extracted cheaply and sold at a good price, and this is why the sardine is such a problem. Other fishes with less oil and less potential wealth can be more easily managed, but in the case of the sardine the oil has been at the bottom of the trouble and will make or break the sardine fishery. The oil has been used in vast quantities for industrial purposes such as paint, soap and linoleum, with only a small portion of it hydro-genated for human food. In the canned sardines the oil accounts for the high food value and rich flavor of the fish, but the amounts of oil that have gone into cans are small compared to the amounts that have been extracted and shipped out in tank cars. Sardines congregate in great schools and can be caught in quantity at low cost, so that the extracted oil can be produced and marketed in successful competition with vegetable and animal fats such as cottonseed oil and lard. This explains why our supply of sardines has suffered such a heavy drain. The fish flesh, after oil and water have been pressed out, is dried and ground for marketing as fish meal (stock food and fertilizer), but fish meal production is only incidental to oil extraction in the sardine reduc-

¹ Presented for publication, April 27, 1938.

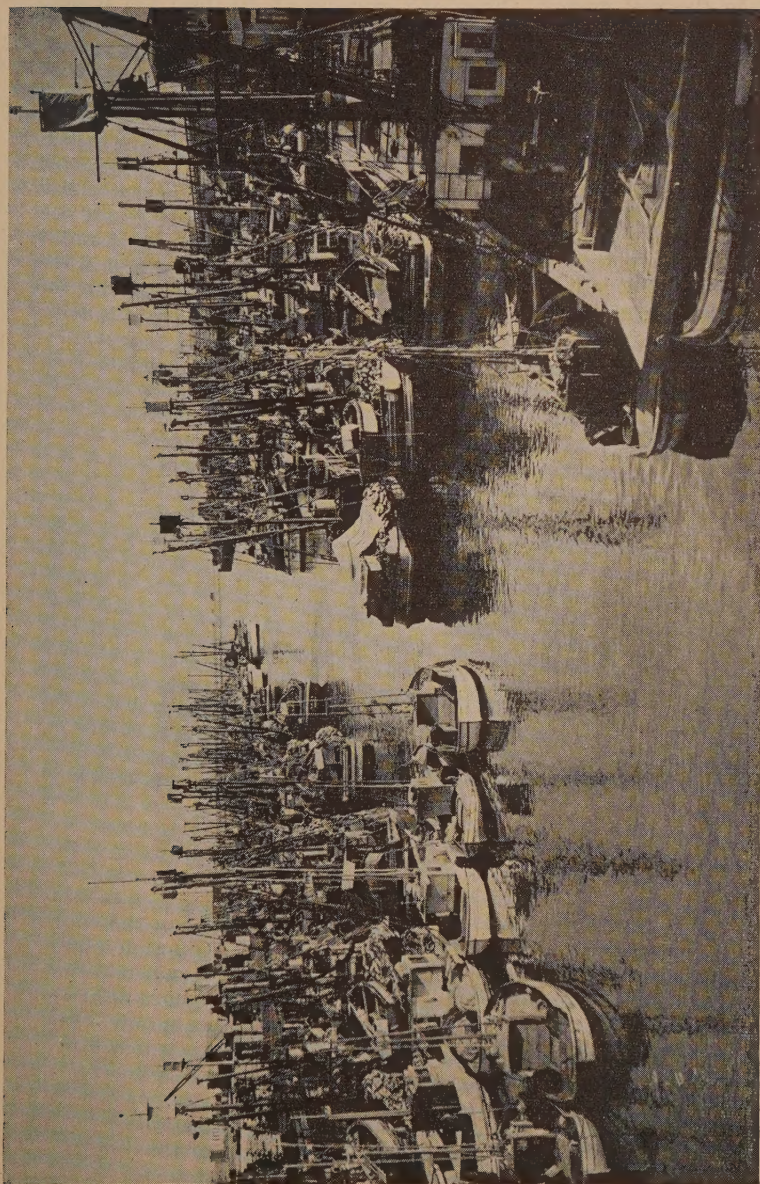


FIG. 74. Approximately half of the San Pedro sardine fleet of purse seine boats photographed March 5, 1938, by Richard S. Croker. The small market boats in the left foreground are not purse seiners and they fish sardines only as bait. This forest of fishing boat masts partially explains where our sardines have gone.

tion plants of the State. The sale price of fish meal goes a long way toward paying the costs of operation, but it is the sardine oil that brings in the real money. Even the canning of sardines has become almost a side line to the extraction of sardine oil.

Early in the management of her fisheries, California adopted the policy that her fish should be used as food for man and should not be converted into meal and oil for industrial purposes, but an exception was made in the case of sardines. The excuse given for this exception to the general policy was that it would assist in the development of the then infant industry, but the ready money in the oil began to cause trouble almost from the start. The first cannery dumped at sea the scrap (offal) left from canning, but soon small reduction plants were established to use the offal and avoid polluting the ocean with waste fish material. Then the profit in oil was discovered and the reduction plants grew in capacity at an astonishing rate. With increased capacity,



FIG. 75. Sardine boats: foreground, a Monterey lampara launch which was typical of the sardine fishing boat at that port only a few years ago; background, a purse seine boat typical of the modern sardine fleet. Photograph by J. B. Phillips, October, 1930.

more sardines were needed. Thus began a long struggle in the courts and in the Legislature to use whole sardines in the reduction plants. More plants were built and canned goods were rushed to market, sometimes at less than the cost of production in order to get more offal and more whole fish into the reduction plant for the profitable oil. Step by step the Legislature yielded to the demand for more whole fish in the reduction plants, till finally the lid was off and the reduction of whole sardines ran practically wide open.

The story of the struggle against unrestricted reduction of whole fish has been an interesting chapter in the development of this industry, but the questions involved are a little too complicated to be covered here. However, one or two of the principles can be mentioned briefly as they are still operative and will be of importance in future discussions of the sardine industry. When a sardine is to be canned, the head is

cut off well back on the body of the fish so as to clean the body cavity, and about one-third of the total weight is discarded as offal. Broken, crushed and off-sized fish are not used in the can and are roughly classed as offal, so that from a ton of sardines canned there is 40 to 50 per cent of the weight that does not enter the can but goes to the reduction plant as offal for conversion into oil and meal. A ton of sardines in suitable condition and of proper sizes will produce roughly 22 cases (48 oval one-pound cans to the case), but to allow for broken or small fish 20 cases per ton was adopted as standard. This allowed roughly half of each ton to go into the reduction plant as offal, but this half was offal plus a certain amount of whole fish. Then there was pressure to lower the number of cases required per ton so that more whole fish could be reduced and the 20-case requirement was dropped to 18, 15 and now to $13\frac{1}{2}$ cases per ton, thus allowing more and more whole fish to go into the offal pit for the production of oil and meal. The leeway or tolerance allowed by the lowered case requirements made possible the use of increasing amounts of whole fish not cleaned for canning and this whole fish has become known locally as "overage."

Oil profits from "offal" and "overage" induced several changes in the sardine law so that a system of "special permits" developed under which additional whole fish, with certain restrictions, could be reduced to oil and meal. Each ton of additional whole fish meant ready money in sardine oil. Thus there was fish scrap from cleaning, plus whole fish allowed under the low case requirement, plus whole fish under special permit. In that way only a very small proportion of the sardine catch entered cans but a very large part went to oil and meal in the reduction plant. Oil meant money and ever increasing amounts of sardines were needed to supply the demand for oil.

A canning operation where all sardines are used for human food results in one-third to one-half the weight converted into meal and oil. This meal production from offal alone is more than the State consumes, which is ironical because the farmers of the State have been led into favoring unrestricted sardine reduction for the sake of cheap fertilizer and poultry and stock feed. This was dust in their eyes. The supporters of unrestricted reduction desired more oil, not more meal, and the normal amount of by-product meal from offal in canning is greater than the State consumption, so meal is shipped out of the State. Shipping out additional meal would not lower the price locally. The farmers were hoodwinked into supporting one of their competitors in the production of animal fat.

This story of the growth of the oil business should not give the reader the false impression that all sardine cannerymen favored developing an oil rather than a canning business. Many of them felt that the huge catch for oil was a mistake and actively opposed sardine reduction except as a by-product of canning. If the catch of sardines could have been limited to canning, the great increase in catch would have been avoided and the sardine problem would now be just another routine job in fishery management. But part of the men in a group of business competitors can scarcely afford to hold back on principle and refuse quick profits which others in the same business are harvesting, yet in spite of the quick profits, the leading cannerymen of the State were actively supporting the Division of Fish and Game in its efforts

to cut down on the oil production and bring the industry back to a basis of canning. They could see the handwriting on the wall and felt that the sardine supply could not stand up under such a heavy strain. Most of the canners believed that the sardine catch should be curtailed instead of allowed to increase each year, and as long as six years ago they were willing to accept the recommendations of the Division that the catch for the State should have a fixed maximum limit each year. The limit originally proposed by the Division was 250,000 tons per year, but 300,000 tons was the figure of later discussions. This limit was to be applied as a beginning and the amount was to be decreased later if it proved to be too high. This amount was to be allotted among the canners on some basis of canning capacity and past performance, and it began to look as though the problem

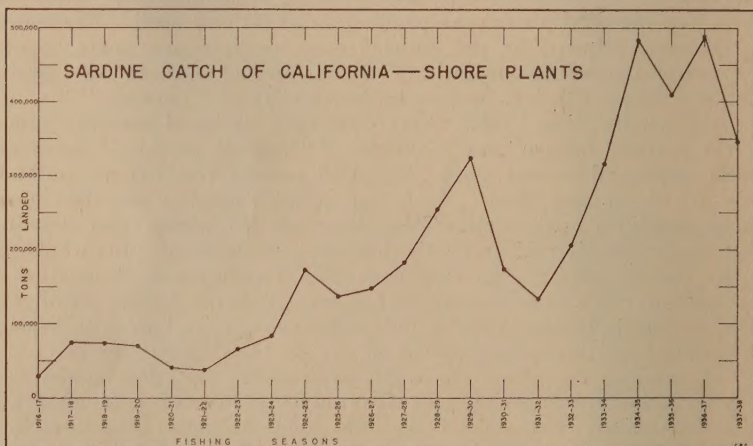


FIG. 76. The California sardine catches by fishing seasons, exclusive of deliveries made to off-shore reduction ships. Fluctuations of catch have followed roughly the changes in economic conditions throughout the country, but the general trend of the catches over this 22-year period has been upward due to increased fishing effort.

child had grown up into a sensible and useful citizen, when someone threw a monkey wrench into the proceedings.

A year or two before this, a trial had been made at reducing sardines on the high seas outside State jurisdiction and thus to gain completely unrestricted tonnage for oil with no canning whatever to hamper oil production. The trial was not promising the first two seasons, but later it succeeded in a big way and a number of ships were outfitted to reduce sardines beyond the three-mile limit. This wide-open reduction blocked the plan of restricting the sardine catch. The shore plants could not cut their operations to a canning basis while their successful competitors on the high seas were operating reduction ships unrestricted. Nor would the State Legislature curtail the established shore industry, employing nearly 10,000 cannery workmen, while unregulated competition from reduction ships threatened to run the canners out of business. Thus, at about the depth of the 1930-1934 depression when relief rolls were bulging, our Legislature and Divi-

sion of Fish and Game felt that they had no alternative but to help the shore plants, and permits were granted for additional amounts of sardines to be diverted to reduction plants ashore. This caused a local island of prosperity in the sea of depression and fishermen left the relief rolls for sardine fishing.

Sardine reduction created local prosperity along the water front, but the jubilation was short lived, for soon it was discovered that the heroic depression treatment was proving to be more of a curse than a blessing. The supply of sardines could not stand up under an additional strain at a time when the strain should have been lessened. The supply of fish was already overtaxed and increasing the annual catch did not help a bit. (See Fig. 76.)

Overfishing for a period of years is now causing a collapse in the supply of sardines and after the too merry dance we now face the irksome task of paying the piper a debt long overdue. Our sardine catch will diminish automatically because the supply left in the ocean can not furnish the huge catches of the past few years. This form of automatic catch curtailment will not help the future of the industry, because as the supply of fish dwindles the fishermen will take too great a proportion of what remains in the ocean till we reach a point where sardines will be so scarce it will no longer pay to fish for them. That will mean the resource has been mined out and the sardine plants abandoned as "ghost towns."

Overfishing for all practical purposes means an annual catch greater than the replacements each year by young recruits. A catch greater than replacements cuts down the growing stock. If the overcatch can be curtailed soon enough, it may not have done great damage to the stock, but a long continued overdraft will seriously cut down the stock in the ocean. Future catches must then be drastically cut so as not to exceed replacements in the diminished ocean stock. Even when the catch is curtailed to equal replacements in the smaller stock, we have a fishery running in low gear. Of course, the annual catch should not exceed replacements but if allowed to do so and the fact is discovered in time, the catch can be cut down and the stock on hand can be built back to its former level. From then on the annual crop can be maintained at a maximum with a full growing stock to spawn a full quota of new fish each year. This is an ideal picture not often attained, but the essential fact is that when we find an ocean population has been seriously overfished, we are faced with the choice of letting it dwindle to almost zero by the process of diminishing returns, or we can regulate the annual catch so as to build back the ocean stock and thereby increase the future annual harvests. Obviously the resource should be managed to maintain a full spawning and growing stock so that the annual catch can be maintained continuously at the maximum.

A restriction of annual catch hurts but also it hurts to have a valuable resource vanish and thereby cut off future catches entirely. Our ever present sardine problem child is now faced with the inevitable prospect of receiving severe hurts. The catch will be far less than in the past. If we could bear up under a still more severe restriction of catch till the ocean stock was built back to its former level, then the damage from overfishing could be repaired and eventually we would

be reaping a large annual harvest again. That annual harvest should never be as great as it was from 1934 to 1937, because such an excessive catch would again be overfishing and cutting down our ocean stock instead of maintaining it at a high level of productivity.

The simple sketch of figure 77 illustrates diagrammatically what has happened in our sardine fishery and what may happen in the future. The black line of the curve represents the past trend of the sardine catch in California which rose rapidly each year with the addition of more and bigger fishing boats. Finally we reached a point where added fishing effort would not increase the annual catch. Worse still, added boats could not hold the catch at its former level because overfishing had gone on too long and the sardine supply started to collapse. That is where we stand at present (the 1937-38

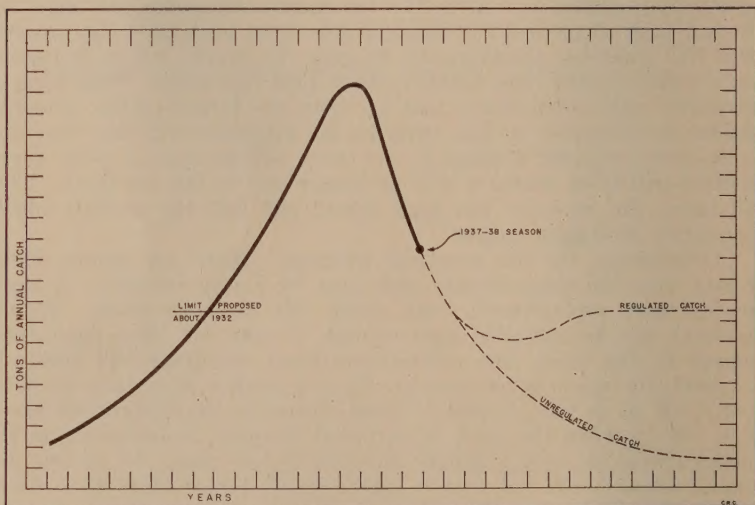


FIG. 77. Diagram to show the California sardine catch of the past as a solid line and the trend of catches in the future as dotted lines.

fishing season just closed). Very likely the collapse will continue even though we deliberately cut the annual catch to a figure far below the present level. But if the catch can be cut to a point where it is below the amount of young fish replacements, then we can build back the depleted stock over a period of years to its former productive level. From that point on, the catch could be adjusted to approximately equal the replacements and that would give us the ideal maximum annual yield. We can assume that the ideal maximum level would be somewhere in the neighborhood of the 250,000 ton limit proposed about six years ago by the California Division of Fish and Game, but this of course would have to be determined by trial. If we do not sufficiently curtail the yearly harvest, our ocean stock will be still further diminished and future catches will be correspondingly less. The logical outcome of unregulated catch is the economic balance where the fish are so scarce it is economically unprofitable to expend much effort searching for them and we can then maintain our supply at that low

level. When our sardines increased in numbers they would be caught and when abundance decreased, fishing would stop except for an occasional museum specimen. This may sound silly, but it has been argued by a few people with no outward sign of jesting that we need not be concerned about our sardine supply, for it will adjust itself at an economic level if left alone. The tragic jest is that our sardine probably would do just that if left alone. The buffalo did.

Adequate management of a fishery requires considerable knowledge of changes in abundance, methods for measuring abundance, survival success of spawnings, and usually we need to know the character of the stock in the ocean and much of the life-history of the species, such as spawning habits, migrations, growth rate and size at sexual maturity. In the case of the sardine we already have much of this information, for the Division of Fish and Game arranged that the California State Fisheries Laboratory should conduct a study of the sardine fishery and work started twenty years ago, in February, 1918. More systematic and intensive work began the following year and a comprehensive plan of study was drawn up in 1919 and published.² As the work progressed the results were published and our bulletins and pamphlets on the sardine when all assembled make a small armful. Throughout, our chief concern has been with adequate methods for determining the supply in the ocean and changes from year to year in the supply, especially those changes caused by man's fishing.

Beginning in 1920 and at intervals thereafter it was pointed out that a too extensive enlargement of the sardine fishery was very apt to lead to depletion, and officials of the Division of Fish and Game tried in every way to prevent the establishment of independent reduction plants and endeavored to hold the industry on a strictly canning basis so as to avoid over-utilization of the supply. Eight years later the danger signs of overfishing had appeared and more specific warnings were issued to point out breakers ahead. At the State Legislature in March, 1929, the indications of overfishing were explained and a plea made to confine the use of sardines to canning. By 1930 the indications of depletion were so serious that State officials and leaders of the sardine industry were officially warned at a meeting of the Joint Assembly Interim Committee held in San Pedro on April 16, 1930. At this meeting the danger signs were explained and discussed. Similar warnings appeared in our published bulletins and in the published Biennial Reports of the Division of Fish and Game. Mimeographed predictions of a sardine shortage, dated August 29, 1933, were distributed and the following year a similar prediction was published,³ but during these years any suggested curtailment of the sardine catch was opposed on the grounds that the evidence presented by the research staff was not positive proof of serious depletion. Obviously our research staff was unable to offer positive proof of serious depletion till it had occurred, but the indications of lessened supply were presented and it was then urged that the time was at hand to begin locking the stable doors before the horses were gone. This record of warnings and predictions is not presented in a spirit of "I told you

² The proposed investigation of the sardine. Calif. Fish and Game, vol. 6, pp. 10-12, 1920.

³ The 1934-1935 sardine season. Calif. Fish and Game, vol. 20, pp. 298-300, 1934.

so'' or a futile crying over spilled milk, but it is merely in answer to the question that someone is sure to ask soon, "why didn't you tell us?"

While answering a question before it is asked, possibly a few of the questions that already have been asked should have the answers repeated briefly. One such question is why is the use of food fish in a reduction plant allowed? The answer is that the law prohibiting the use of fish in a reduction plant was amended to provide that a revokable permit may be granted to use fish in a reduction plant if certain

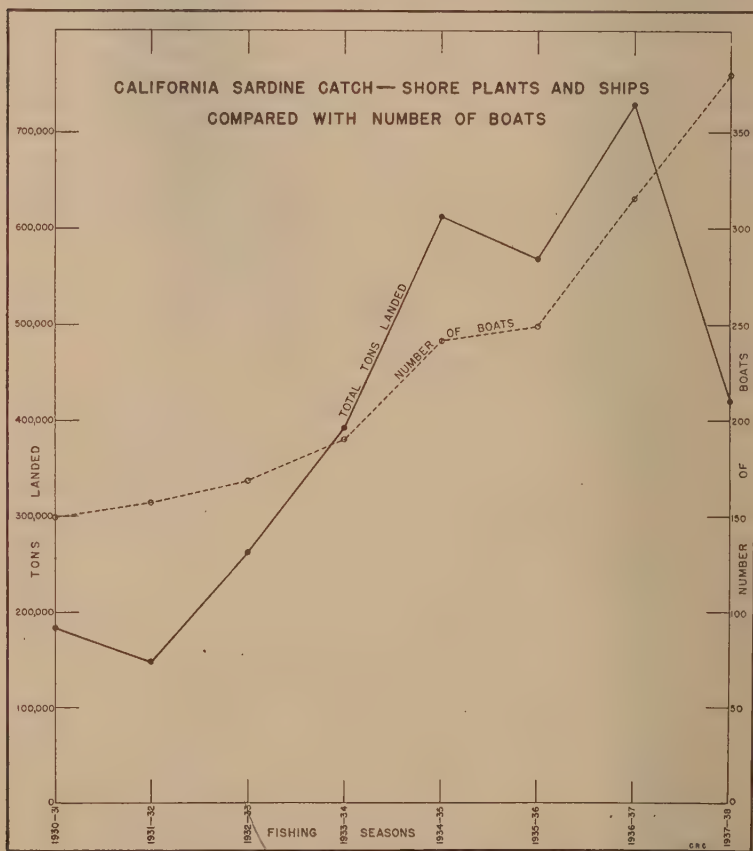


FIG. 78. The sardine catch of the last eight fishing seasons compared with the number of fishing boats employed. In the past the catch could be increased by adding more fishing boats, but we have now reached the point where additional fishing effort will not prevent a drop in the total catch.

restrictions and regulations are complied with. No such permits are granted except for sardines. Fish other than sardines cost too much and have too little oil, so the plant operator would lose money on every pound of food fish (except sardines) put into his reduction plant. He is in business to make money not to lose it, so the only fish he reduces is sardines. As the prices paid for other species are based on their

value as food, and the heads and viscera resulting from cleaning operations would otherwise be wasted, the offal of all kinds of fish is converted into oil and meal at a slight profit. This margin of profit would disappear if the expensive whole fish were reduced, consequently barracuda, white sea-bass and other sport and food fishes are not used in California reduction plants.

We have been asked if the recent drop in the sardine catch is our principal evidence of depletion. The answer is that the total catch is a measure of what is taken out, not what is left in the ocean. The sardine total catch measures the abundance of sardines on the cannery floor, not the abundance in the sea. The catch is the result of fishing effort and under normal conditions we can increase the total catch by increasing the fishing effort. The **catch per unit of fishing effort** is significant and is one of the best ways of measuring abundance in the ocean. If the return in fish for a given unit of fishing effort drops down over a period of years, then this catch per unit of effort is a strong indication of a drop in abundance of fish in the ocean. In some cases fishing effort can be measured roughly by the number of boats employed in the fishery, but there is more to fishing effort than the number of boats engaged. Some boats may be larger than others, fish longer hours, have bigger or better nets or help each other locate fish and thereby increase their catches. In the sardine fishery the boats have completely changed in the last twenty years. (See Fig. 75.) Not only are there more boats but each boat is larger, fishes longer, can go farther for fish, uses different gear, larger nets, and many use radio-telephone. The average sardine boat today can catch at least five times as many sardines as the average boat twenty years ago. In 1919 the largest sardine cannery in the State could handle 100 tons per day by working overtime, and six fishing boats did occasionally deliver as much as 100 tons in a day to this cannery. Fifteen years later one of the newer boats could swamp such a cannery with two-thirds of its catch, and such a boat frequently delivered more fish than the six boats had caught in 1919.

In spite of this great increase in the catching power and efficiency of the fishing boat, we can get a rough idea of fishing effort during recent years by knowing the number of boats engaged in the fishery. (See Fig. 78.) The improvement in fishing boats has continued but changes during the last six or eight years may not have been quite as great as in former years. All this means that sardine fishing effort has increased greatly in twenty years and the number of boats employed in the fishery tells only part of the story. Increased fishing effort brought the sardine total catch up to an all-time high during the fishing season of 1936-37, and the following season more than 60 additional fishing boats joined the fleet in the hope that the 1937-38 season would be even larger, but the total catch of the augmented fleet of 380 boats made a catch only about 60 per cent as large as in the preceding season. Naturally, it would be unwise to jump at conclusions as the result of one bad year, but our conclusions are based on observations over a twenty-year period, and eight years ago there were strong indications that the average boat was having increasing difficulty in making its catch. By the time of the peak season, 1936-37, many of the fishermen recognized the truth of our contention that sardines were

becoming decidedly scarce compared with earlier years. The big catch of 1936-37 resulted from adding about 65 new boats that year, but the average boat did not do well and many boat owners were discouraged. Then the following poor season added black crepe to their gloom and they reluctantly admitted that the sardine supply was in a state of collapse. Increased fishing effort will increase the total catch within reasonable limits, but if the supply of fish is too greatly diminished then the total catch can not be increased no matter how great the effort. In this extreme, greater effort can not catch fish that are not in the ocean to be caught.

Since the sardine boats fish only in a narrow strip along the shore and the Pacific Ocean is so large, how is it possible that there should be a serious depletion of sardines? It is true that sardine fishermen do not go much beyond the 500-fathom depth line and this is because they fish where the fish are. Sardines are not uniformly diffused throughout the Pacific; our species is confined to a narrow belt along the shore. As they move up and down the coast, overfishing in a small area drains the supply and long continued overfishing in the coastal strip of water can reduce the ocean stock of sardines to the vanishing point. The great sardine fishery of Japan does not take our sardine. The Japanese catch is made up of several species, no one of which is the same as our species. The catch in Japan is made over a much larger area than we have on our coast, and though the Japanese catch is great their fishery per square mile is far less intensive than in our fishery. These points have been covered in detail by our sardine publications.

The following questions concerning sardines are frequently asked so brief answers are given with a few of the references to publications which explain fully the answers.

1. Is the California sardine a true sardine?

Answer: Yes.

Reference:

The California sardine. Calif. Fish and Game Comm., Fish Bull., no. 11, pp. 8-17, 1926.

2. Is the California sardine different from the Japanese sardine?

Answer: Yes. Our sardine differs distinctly from that of Japan.

The California sardine is a larger species and the two forms are entirely separated geographically.

Reference:

Same as above.

3. What is the northern and southern range of our sardine?

Answer: The California sardine has been taken as far north as southern Alaska, off the outer coast of Vancouver Island, along the entire coast of Washington, Oregon, California, Lower California, and into the Gulf of California.

References:

The California sardine. Calif. Fish and Game Comm., Fish Bull., no. 11, pp. 8-17, 1926.

A summary of the life-history of the California sardine. . . . Calif. Fish and Game, vol. 21, no. 1, pp. 2-3, 1935

4. Are sardines found only near shore?

Answer: Yes. We have no records of sardines having been seen or caught more than 300 miles from land.

Reference:

Early life-history of the California sardine. . . . Calif. Div. Fish and Game, Fish Bull., no. 41, p. 7, 1934.

5. Where are most sardines caught?

Answer: Sardines are taken in commercial quantities from British Columbia south to the Mexican waters. All of the fishing grounds lie close to shore over depths not greater than 500 fathoms.

References:

Fishing areas along the California coast for the sardine. Calif. Div. Fish and Game, Fish Bull., no. 25, pp. 12-14, 17-21, 28-33, 38-39, 40-44, 1930.

Fishing localities for the California sardine, 1928-1936. Calif. Div. Fish and Game, Fish Bull., no. 48, pp. 1-11, 1937.

Yield per area of the California sardine fishing grounds, 1935-1937. Calif. Fish and Game, vol. 23, no. 4, pp. 307-309, 1937.

6. Do our sardines go to Japan?

Answer: No. The sardine found in Japan is a different species than that found in our waters. Sardines have been tagged off British Columbia and the various localities off California. Recoveries of these tags show that our sardines move up and down the British Columbia, Washington, Oregon and California coast.

References:

First report of sardine tagging in California. Calif. Fish and Game, vol. 23, no. 3, pp. 190-192, 1937.

Northern recovery of California sardine tags. Calif. Fish and Game, vol. 24, no. 1, pp. 70-71, 1938.

7. Where do sardines spawn?

Answer: Sardines have been known to spawn as far north as San Francisco, as far south as Lower California, but the main spawning grounds are off Southern California from Pt. Conception to San Diego, within 100 miles of shore.

References:

Early life-history of the California sardine, with special reference to the distribution of the eggs and larvae. Calif. Div. Fish and Game, Fish Bull., no. 41, pp. 5-25, 1934.

The relation between surface water temperature and the distribution of spawn of the California sardine. Calif. Fish and Game, vol. 23, no. 2, pp. 132-137, 1937.

8. When do sardines spawn?

Answer: The spawning season for the California sardine is from February through July. The peak of the spawning is in April and May.

References:

Early life-history of the California sardine, with special reference to the distribution of the eggs and larvae. Calif. Div. Fish and Game, Fish Bull., no. 41, pp. 7-8, 1934.

Maturity of the California sardine. . . . Calif. Div. Fish and Game, Fish Bull., no. 42, pp. 25-34, 1934.

9. Do they spawn more than once each year?

Answer: There is only one spawning season for the sardine in the spring and early summer. During this four- to five-month time interval each individual fish may spawn as often as two to four times.

Reference:

Maturity of the California sardine. . . . Calif. Div. Fish and Game, Fish Bull., no. 42, pp. 14-19, 1934.

10. Do sardine eggs float freely in the ocean?

Answer: Yes. The eggs are found floating at and near the surface.

Reference:

Early life-history of the California sardine, with special reference to the distribution of the eggs and larvae. Calif. Div. Fish and Game, Fish Bull., no. 41, pp. 1-44, 1934.

11. How many eggs are spawned?

Answer: The number of eggs produced by a female at one spawning varies from 35,000 to 65,000. Larger fish produce more eggs than small ones.

Reference:

Maturity of the California sardine. . . . Calif. Div. Fish and Game, Fish Bull., no. 42, p. 21, 1934.

12. What do sardines eat?

Answer: Sardines feed on minute plants and animals floating freely at the surface of the ocean.

Reference:

Early life-history of the California sardine. . . . Calif. Div. Fish and Game, Fish Bull., no. 41, pp. 25-29, 1934.

13. What gear is used to catch sardines?

Answer: Sardines are taken in three kinds of round haul nets, called purse seines, ring nets and lamparas.

References:

Methods of sardine fishing in southern California. Calif. Fish and Game, vol. 7, no. 4, pp. 219-237, 1921.

The ring net, half ring net, or purse lampara in the fisheries of California. Calif. Div. Fish and Game, Fish Bull., no. 27, pp. 7-16, 1930.

Sardine fishing methods at Monterey, California. Calif. Div. Fish and Game, Fish Bull., no. 19, pp. 19-36, 1929.

Success of the purse seine boat in the sardine fishery at Monterey, California. . . . Calif. Div. Fish and Game, Fish Bull., no. 23, pp. 5-16, 1930.

14. Are the same sized sardines taken throughout each fishing season?

Answer: No. During the fall and early winter months, the fishery draws on smaller and younger adults. In the winter and early spring months, the larger older adults are taken.

References:

The California sardine. Calif. Fish and Game Comm., Fish Bull., no. 11, pp. 132, 139, 200, 1926.

. . . Changes in size of the California sardine. Calif. Div. Fish and Game, Fish Bull., no. 47, pp. 1-13, 1936.

Seasonal average length trends at Monterey of the California sardine.

Calif. Div. Fish and Game, Fish Bull., no. 13, pp. 1-12, 1928.

Seasonal changes in the daily average length of the California sardine.
Calif. Div. Fish and Game, Fish Bull., no. 26, pp. 1-20, 1930.

15. Is the supply being depleted?

Answer: Yes. The first evidences of overfishing were shown by an extension of the fishing grounds to meet the greater demands of the industry. These were followed by a shortening of the life span of each year-class in the fishery. At the same time the fishermen were having to develop more efficient methods and to work harder to obtain the same sized catches. During the past sardine season the return to each individual fisherman has been very much reduced in spite of very efficient fishing methods.

References:

. . . Changes in sizes of the California sardine. Calif. Div. Fish and Game, Fish Bull., no. 47, pp. 26-27, 1936.

Changing abundance of the California sardine measured by length of scouting time. Calif. Fish and Game, vol. 19, no. 2, pp. 136-141, 1933.

Fishing areas along the California coast for the sardine. Calif. Div. Fish and Game, Fish Bull., no. 25, pp. 22-23, 33-38, 1930.

16. What is the program of study?

Answer: Determination of changes in abundance, estimates of population, spawning success and such life-history data as offer a promise of aiding in the management of the sardine fishery. California's first contribution to fisheries science was the formulation of a comprehensive program of fact-gathering for the purpose of managing our fisheries on a basis of sustained yield. This long range program has been carried on without interruption for a period of twenty years. The purpose of our studies, the methods used and results obtained have been fully published at frequent intervals. Statement and explanation of the program appeared in the following references:

The proposed investigation of the sardine. Calif. Fish and Game, vol. 6, pp. 10-12, 1920.

The scientific investigation of marine fisheries, as related to the work of the Fish and Game Commission in southern California. Calif. Fish and Game Comm., Fish Bull., no. 2, 26 pp., 1919.

Biennial Reports of California Division of Fish and Game, as follows:

No. 26, 1918-1920, p. 61	No. 31, 1928-1930, p. 130
No. 27, 1920-1922, p. 75	No. 32, 1930-1932, p. 80
No. 28, 1922-1924, p. 58	No. 33, 1932-1934, p. 55
No. 29, 1924-1926, p. 75	No. 34, 1934-1936, p. 50
No. 30, 1926-1928, p. 118	

A FISHERIES LIBRARY AND ITS USES¹

By KATHERINE KARMELICH

California State Fisheries Laboratory

Division of Fish and Game

Visitors to the California State Fisheries Laboratory are often surprised to find that we have a library where so much literature is available on fisheries and allied subjects dealing with the science of the sea. Perhaps it is because the fishing industry is considered by the romantic public as nothing more than the picturesqueness of the fishermen going to sea. And, perhaps it is because fishing to others simply means the efforts of the fisherfolk to provide fish for the nation's table. However, it is much more than that. The fishing industry compares favorably in magnitude and financial status with major and better known enterprises. For today, fish are not only eaten but they furnish a source of material for manufacturing such products as medicine, paint, soap, linoleum, cattle feed, and various other commodities, which we more or less take for granted without realizing their origin. In order to maintain this industry for the welfare of the people and keep it on a profitable scale for future generations, we must learn something about the life in the sea. This means an understanding of the habits, food and migrations of the various inhabitants, which necessitates delving into the mysteries enveloped by the vastness of the ocean.

The need for such knowledge about the fisheries of California led to the initiation of fisheries research work in 1917 and the establishment of the California State Fisheries Laboratory by the Division of Fish and Game. This was done through the farsightedness of N. B. Scofield, chief of our Bureau of Marine Fisheries, and his associates. Immediately the importance of a library in this specialized field was felt, and about this nucleus has grown an extensive library, which now comprises a large collection of marine biological literature emanating from various countries throughout the world.

A library is essentially an indispensable tool in any type of research, whether conducted for commercial or purely scientific purposes. This is illustrated by the number of special libraries established by commercial companies, government bureaus and other agencies for their particular uses. Much time and effort can be saved through the facilities offered by a library, as needless repetition of work is eliminated through a knowledge of what has already been done, and discoveries in one particular phase of research can be applied in allied investigations. The library is the center of such information and is therefore intrinsically a part of research.

Closely interwoven with the principles of the workers of the Division of Fish and Game to serve the people by studying the natural resources and advising on the best means of conservation in order that full benefit may be received, are the aims of the library also to

¹ Submitted for publication, April, 1938.

serve by disseminating the information contained in its archives. The library was primarily established for the research staff in order that they might have access to the published results of investigations conducted in similar lines by other governmental and private agencies. But, with the expansion in the California fishing industry, the library is now not only consulted by the personnel of the Division but by various commercial concerns, the fish canning industry, fishermen, scientists engaged in research for other organizations (United States and foreign), students, motion picture companies, and others, besides the "Izaak Waltons" in the sport fishing field.

Although the library is for reference purposes only, the literature in the library is available to everyone for consultation and it is an interesting part of the day's work to answer the questions of those



FIG. 79. The library of the California State Fisheries Laboratory, Terminal Island, California.

visiting the library. The inquiries deal with varied subjects, such as chemical analysis of fishes; bacteriology of fresh and preserved products; whether a dolphin is a fish or a mammal; tanning of shark hides; identification of marine specimens; fish culture; parasites in fishes; frog farming; methods of preservation of fishery products (commercial and home canning, smoking, salting, etc.); fish oil and meal; geographic distribution, habits and anatomy of fishes; fisheries statistics in this and other countries; fishing methods and gear; foreign fisheries; sport fishing; pollution; mollusks; crustaceans; pearl essence; equipment of aquariums for commercial and private uses; and innumerable others. Requests by mail for information are also received almost daily.

In order to serve those employees of the Division of Fish and Game who are out in the field and thus lack the facilities of a library, lists

of the literature received each month are compiled and distributed. In this way, they are informed monthly about the latest publications, which the library then makes available to them. This list is now not only sent to our staff members but to others not in the employ of the Division, who express a desire to know of the current literature.

Another method of disseminating information is our circulating or "grapevine" library, suggested by H. B. Nidever, field inspector for the Division of Fish and Game. This is reserved for the Division employees, principally for the wardens stationed away from headquarters where they have no means of securing books to further their knowledge about the natural resources (including marine biology and fisheries), principles of conservation, and law enforcement. The books are circulated, and after one man reads a book, he passes it on to a co-worker, mailing to the library a card (supplied for that purpose) with the name of the person to whom the book is given, in order that a record may be kept. After the book is read by all interested persons, it is then returned to the library. This "grapevine" method has met with the enthusiasm of the employees.

Another service of the library is the compilation of bibliographies of literature on specific subjects for the general public as well as for the employees of the Division. Thus, bibliographies on tuna, sardines, mackerel, refrigeration, fish eggs and larvae, barracuda, etc. have been prepared. The tuna, sardine and barracuda bibliographies have been published.² A subject and author index to volumes 1-20 (1914-1934), inclusive, of "California Fish and Game," was compiled and published.³

To make for immediate access to the literature, the California State Fisheries Laboratory library is classified and cataloged. Because of its specialized material, the standardized decimal system used generally in public libraries was not directly applicable to our library. It was therefore necessary to make modifications and additions to the decimal system in order that the literature could be classified properly. Another consideration was that the system should be flexible and expansive enough to allow for future enlargement of the library.

The card catalog of authors and subjects, filed alphabetically, is an important tool. New accessions are cataloged as received, so that the card file is kept up to date. This catalog now contains many thousands of cards. Pamphlets in the form of special reports, articles in magazines and those reprinted from journals, and government publications are treated and cataloged individually. Pamphlets and magazines are given just as much importance if not more than bound books, as the reports issued in the frequently published journals contain the most recent information available on the subject. Bound books are often compilations of what has already been made known.

It is essential to keep a constant lookout for all new reports and books in order that the library may have every important published contribution bearing on fisheries research work and allied subjects.

² Corwin, Genevieve. A bibliography of the tunas. Calif. Div. Fish and Game. Fish Bull., no. 22, 103 pp., 1930.

Wheeler, Genevieve C. A bibliography of the sardines. Calif. Div. Fish and Game, Fish Bull., no. 36, 133 pp., 1931.

Walford, Lionel A. The California barracuda (*Sphyræna argentea*). I. Life history of the California barracuda. II. A bibliography of barracudas. (Sphyrænaidae). Calif. Div. Fish and Game, Fish Bull., no. 37, pp. 73-120, 1932.

³ Calif. Fish and Game, vol. 22, no. 4, app., 60 pp., 1936.

However, it is the policy not to secure a set of journals or books just for the sake of completeness, but rather to have only those parts of the set which are of particular use in the library.

The library now (April 30, 1938) contains approximately 2086 bound volumes and 31,155 pamphlets (unbound) including serial publications. A very large part of this collection is secured free of charge by exchanging the publications of the Division of Fish and Game ("Fish Bulletins," "California Fish and Game," etc.) for those of other agencies, societies, government bureaus and individual authors. We are therefore indebted to these sources for their contributions. If it had been necessary to purchase all the literature in the library, the cost would have been enormous. As it is, because so much has been and is available without charge through exchange arrangements, the financial maintenance of the library is really comparatively low. Through the facilities of a loan service with university and public libraries, we are able to borrow those books and journals which are only occasionally referred to or the cost of which is prohibitive.

In order to show the type of literature in the library, the following list of major subjects with a few references is appended. The subject classifications are of necessity very general, as space does not permit a detailed and more specific grouping of subjects with complete bibliographic references for each. The list is simply to serve as an illustration and is by no means a comprehensive representation of the library. Although some serial publications, mentioned below, are listed under such general classifications as "Biology, Ecology, and Science in General," they include specific reports on marine biological and fisheries subjects. Such papers are frequently found scattered in scientific journals dealing with various subjects.

BIOLOGY, ECOLOGY, AND SCIENCE IN GENERAL

Textbooks on these subjects.

Periodicals such as *Nature* (London), *Natural History* (New York), *Science and Scientific Monthly* (New York).

Publications of various organizations throughout the world, including:

Academy of natural sciences of Philadelphia.

American museum of natural history, New York City.

Bernice P. Bishop museum of Polynesian ethnology and natural history, Honolulu.

Ecology. Ecological society of America. Lancaster, Pa.

Liverpool biological society. Liverpool University Press.

South Australian museum, Adelaide.

Stanford university. Biological sciences. Stanford University, Calif.

Washington. University. Publications in biology. Seattle, Wash.

U. S. National museum. Washington, D. C.

FISHERIES BY-PRODUCTS. *See* TECHNOLOGY

FISHERIES STATISTICS

Official government publications on fisheries statistics of foreign and domestic fishing ports—amount caught, value of fresh and preserved products, etc.

FISHES AND FISHERIES

The library contains works on fishes and fisheries of the world, a few of which are:

Books:

- Alward, G. L. The sea fisheries of Great Britain and Ireland. Grimsby, Albert Gait, 1932, 474 pp., app.
- Barnhart, Percy S. Marine fishes of southern California. Berkeley, University of California Press, 1936. 209 pp.
- Curtis, Brian. The life story of the fish. New York & London, D. Appleton-Century Co., 1938. 260 pp.
- Dean, Bashford. A bibliography of fishes. New York, American Museum of Natural History, 1916, 1917, 1923. 3 vols.
- Faber, G. L. The fisheries of the Adriatic and the fish thereof. London, Bernard Quaritch, 1883. 292 pp.
- Fulton, T. W. The sovereignty of the sea. Edinburgh & London, Wm. Blackwood & Sons, 1911. 799 pp.
- Goode, George Brown. American fishes; a popular treatise upon the game and food fishes of North America with especial reference to habits and methods of capture. Boston, L. C. Page & Co., 1903. 562 pp.
- Günther, Albert. Catalogue of the fishes in the British museum. London, Taylor and Francis, 1859-1870; reproduced by photolithography, Adlard & Son, 1937. 8 vols.
- Jenkins, J. T. The sea fisheries. London, Constable & Co., 1920. 299 pp.
- Jordan, David Starr. Fishes; rev. ed. New York, D. Appleton & Co., 1925. 773 pp.
- Jordan, David Starr, and Evermann, Barton W. The fishes of North and Middle America; a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. Washington, Government Printing Office, 1896-1900. 4 vols.
- Kyle, Harry M. The biology of fishes. New York, Macmillan Co., 1926. 396 pp.
- Meek, Alexander. The migrations of fish. London, Edward Arnold, 1916. 427 pp.
- Norman, J. R. A history of fishes. London, Ernest Benn Ltd., 1931. 463 pp.
- Norman, J. R., and Fraser, F. C. Giant fishes, whales and dolphins. New York. W. W. Norton & Co., 1938. 361 pp.
- Tressler, D. K. Marine products of commerce: their acquisition, handling, biological aspects and the science and technology of their preparation and preservation. New York, Chemical Catalog Co., 1923. 762 pp.
- Walford, L. A. Marine game fishes of the Pacific coast from Alaska to the equator. Berkeley, University of California Press, 1937. 205 pp.

Government reports, publications of fisheries societies and other institutions, and periodicals (including trade journals) include those from: Australia, Brazil, Canada, Denmark, Egypt, England, Finland, France, Germany, India, Indo-China, Ireland, Italy, Japan, Mexico, Netherlands, Newfoundland, Union of South Africa, Scotland, Spain, and the United States. The number is too numerous to list all of them.

Reports of fisheries experimental stations, international fisheries commissions, expeditions, congresses.

MATHEMATICS

Textbooks on arithmetic, algebra, geometry, trigonometry, calculus, probabilities.

MOLLUSKS AND CRUSTACEANS. *See also* ZOOLOGY

- Johnson, M. E., and Snook, H. J. Seashore animals of the Pacific coast. New York, Macmillan & Co., 1927. 659 pp.
- Oldroyd, I. S. Marine shells of the west coast of North America. Stanford University Press, 1924-1927. 2 vols.
- Rogers, J. E. The shell book: a popular guide to a knowledge of the families of living mollusks, and an aid to the identification of shells native and foreign. New York, Doubleday, Doran & Co., 1931. 485 pp.
- Webb, W. F. Handbook for shell collectors; illustrations and descriptions of 2,200 species of Mollusca; 4th ed. Rochester, N. Y., 1936. 291 pp.
- Weymouth, F. W. The edible clams, mussels and scallops of California. California. Fish and game commission. Fish bulletin, no. 4, 72 pp., 1920.

OCEANOGRAPHY, HYDROGRAPHY, PHYSICAL FEATURES OF OCEAN Books:

- Ekman, Sven. *Tiergeographie des Meeres*. Leipzig, Akademische Verlagsgesellschaft, 1935. 542 pp.
- Harvey, H. W. *Biological chemistry and physics of sea water*. New York, Macmillan Co., 1928. 194 pp.
- Herdman, W. A. *Founders of oceanography and their work; an introduction to the science of the sea*. New York, Longmans, Green & Co., 1923. 340 pp.
- Jenkins, J. T. *A textbook of oceanography*. London, Constable & Co., 1921. 206 pp.
- Johnstone, James. *An introduction to oceanography, with special reference to geography and geophysics*. Liverpool, University Press, 1923. 351 pp.
- Murray, John, and Hjort, Johan. *The depths of the ocean; a general account of the modern science of oceanography based largely on the scientific researches of the Norwegian steamer Michael Sars in the North Atlantic*. London, Macmillan & Co., 1912. 821 pp.
- National research council, U. S. *Physics of the earth—V. Oceanography*, prepared under auspices of subsidiary committee on oceanography. Washington, D. C., National academy of sciences, 1932. 581 pp.
- Vaughan, Thomas W., and others. *International aspects of oceanography, oceanographic data and provisions for oceanographic research*. Washington, D. C., National academy of sciences, 1937. 225 pp.
- Wegener, Alfred. *The origin of continents and oceans; trans. from third German edition, by J. G. A. Skerri*. London, Methuen & Co., 1924. 212 pp.

Periodicals and publications of commissions, institutions, etc., among which are:

- Archiv für Hydrobiologie. Stuttgart.
- Berlin. Universität. Institut für Meereskunde.
- Carnegie institution of Washington. Tortugas laboratory.
- Cauda. Station maritime. Institut océanographique de l'Indochine. Hanoi, Indo-China.
- Commission internationale pour l'exploration scientifique de la Mer Méditerranée. Monaco.
- Conseil permanent international pour l'exploration de la mer. Copenhagen.
- Dove marine laboratory, Cullercoats, Northumberland.
- Internationale Revue der gesamten Hydrobiologie und Hydrographie. Leipzig.
- Italy. R. Comitato talassografico italiano. Venice.
- Marine biological association of the United Kingdom, Plymouth.
- Monaco. Institut océanographique (foundation Albert Ier, Prince de Monaco).
- Salammbô. Station océanographique. Salammbô, Tunis.
- Scripps institution of oceanography, La Jolla, California.
- Vanderbilt marine museum, Huntington, Long Island.
- Wissenschaftliche Meeresuntersuchungen: Abteilung Helgoland und Keil. Leipzig. (Abteilung Kiel superseded by Kieler Meeresforschungen in 1936. Abteilung Helgoland superseded by Helgoländer wissenschaftliche Meeresuntersuchungen in 1937.)

OCEANOGRAPHIC EXPEDITIONS

A few are:

- Albert Ier de Monaco. *Résultats des campagnes scientifiques accomplies sur son yacht*.
- Carlsberg foundation's oceanographical expedition round the world, 1928-30 and previous "Dana"-expeditions. Copenhagen.
- Discovery reports. Discovery committee. London.

PLANKTON. See also references in sections on OCEANOGRAPHY, OCEANOGRAPHIC EXPEDITIONS

Books:

- Ekman, Sven. *Tiergeographie des Meeres*. Leipzig, Akademische Verlagsgesellschaft, 1935. 542 pp.

Johnstone, James; Scott, Andrew; and Chadwick, H. C. The marine plankton. Liverpool, University Press, 1924. 194 pp.

Lebour, M. V. The planktonic diatoms of northern seas. London, Adlard & Son, 1930. 244 pp.

Publications include:

Conseil permanent international pour l'exploration de la mer. Copenhagen. Denmark. Kommissionen for havundersøgelser. Copenhagen.

REFERENCE BOOKS (General)

Biological abstracts. Philadelphia, Pa.

Zoological record. Zoological society, London.

SEALS AND SEA-LIONS

Allen, J. A. History of North American pinnipeds; a monograph of the walruses, sea-lions, sea-bears and seals of North America. Washington, D. C., Government Printing Office, 1880. 785 pp.

Bonnot, Paul. Report on the seals and sea lions of California. California. Division of fish and game. Fish bulletin, no. 14, 61 pp., 1928.

Scammon, C. M. The marine mammals of the northwestern coast of North America. San Francisco, John H. Carmany, 1874. 319 pp.

SEASHORE AND SEASHORE ANIMALS. *See also* MOLLUSKS AND CRUSTACEANS

Crowder, William. Between the tides. New York, Dodd, Mead & Co., 1931. 461 pp.

Johnson, M. E., and Snook, H. J. Seashore animals of the Pacific coast. New York, Macmillan & Co., 1927. 659 pp.

Newbegin, M. I. Life by the seashore; an introduction to natural history. London, G. Allen & Unwin, 1931. 296 pp.

Wells, Harrington. Seashore life. San Francisco, Harr Wagner, 1937. 271 pp. (Written for children.)

SPORT FISHING

Bergman, Ray. Just fishing. Philadelphia, Penn Publishing Co., 1932. 418 pp.

Fry, D. H., Jr. Trout fishing in southern California streams—instructions for the beginner. California fish and game, vol. 24, no. 2, pp. 84-117, 1938.

Heilner, Van Campen. Salt water fishing. Philadelphia, Penn Publishing Co., 1937. 452 pp.

Holder, C. F. The big game fishes of the United States. New York, Macmillan Co., 1903. 435 pp.

Walford, L. A. Marine game fishes of the Pacific coast from Alaska to the equator. Berkeley, University of California Press, 205 pp., 1937.

STATISTICAL METHODS AND FORMS OF PRESENTATION OF DATA

Books:

Davenport, C. B., and Ekas, M. P. Statistical methods in biology, medicine and psychology; 4th ed., rev. New York, John Wiley & Sons, 1936. 216 pp.

Dunlap, J. W., and Kurtz, A. K. Handbook of statistical nomographs, tables, and formulas. Yonkers-on-Hudson, World Book Co., 1932. 163 pp.

Ezekiel, Mordecai. Methods of correlation analysis. New York, John Wiley & Sons, 1930. 427 pp.

Fisher, R. A. The design of experiments. London, Oliver & Boyd, 1935. 252 pp.

Fisher, R. A. Statistical methods for research workers; 5th ed., rev. & enl. London, Oliver & Boyd, 1934. 319 pp.

Haskell, Allan C. How to make and use graphic charts. New York, Codex Book Co., 1920. 539 pp.

Treloar, A. E. An outline of biometric analysis. Minneapolis, Burgess Publishing Co., 1936 ed. (mimeographed). 193 pp.

Yule, G. U., and Kendall, M. G. An introduction to the theory of statistics. London, Chas. Griffin & Co., 1937. 570 pp.

TECHNOLOGY

For brevity, this grouping includes: preservation and preparation of marine products and their chemical composition; fisheries by-products (fish oil and meal, glue, isinglass, etc.), and other related subjects.

- Cobb, John N. The canning of fishery products. Seattle, Miller Freeman, Publisher, 1919. 217 pp.
- Crocker, R. S. Sardine canning methods in California. California fish and game, vol. 21, pp. 10-21, 1935.
- Gray, A. D. Refrigeration in ships. Philadelphia, J. B. Lippincott Co., 1932. 113 pp.
- Roedel, P. M. Tuna canning methods in California. California fish and game, vol. 24, No. 3, pp. 251-272, 1938.
- Tressler, D. K. Marine products of commerce: their acquisition, handling, biological aspects and the science and technology of their preparation and preservation. New York, Chemical Catalog Co., 1923. 762 pp.
- Prescott, Samuel C., and Proctor, B. E. Food technology; 1st ed. New York & London, McGraw-Hill Book Co., 1937. 630 pp.
- Winton, A. L., and Winton, K. B. The structure and composition of foods. Vol. 3. New York, John Wiley & Sons, 1937. 524 pp.

Many special reports by the Fisheries Research Board of Canada and the U. S. Bureau of Fisheries deal with technological problems.

WHALES AND WHALING

- Dakin, W. J. Whaleman adventures. Sydney, Angus & Robertson, 1934. 263 pp.
- Jenkins, J. T. Whales and modern whaling. London, J. F. & G. Witherby, 1932. 239 pp.
- Norman, J. R., and Fraser, F. C. Giant fishes, whales and dolphins. New York, W. W. Norton & Co., 1938. 361 pp.
- Scammon, C. M. The marine mammals of the northwestern coast of North America, together with an account of the American whale-fishery. San Francisco, John H. Carmany, 1874. 319 pp. (Although it was published about 65 years ago, this is still considered as an authoritative work.)
- Starks, E. C. A history of California shore whaling. California. Fish and game commission. Fish bulletin, no. 6, 38 pp. 1922.
- U. S. Dept. of commerce. Laws and regulations for the protection of whales. (October 9, 1936.) Washington, D. C., Government Printing Office, 1936. 9 pp.

ZOOLOGY

Books:

- Clark, A. H. Animals of land and sea; 2nd ed. enl. New York, D. Van Nostrand Co., 1927. 312 pp.
- Harmer, S. F., and Shipley, A. E., ed. Cambridge natural history. New York, Macmillan & Co., 1909-1920. 10 vols.
- Hegner, Robert, and Hegner, Jane Z. Parade of the animal kingdom. New York, Macmillan & Co., 1935. 675 pp.
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Publications of museums, universities, etc., include:

- Berlin. Zoologische Museum.
- California. University. Publications in zoology. Berkeley.
- Harvard college. Museum of comparative zoology. Cambridge, Mass.
- Michigan. University. Museum of zoology. Ann Arbor, Mich.
- New York zoological society. New York.

**ZOOLOGY—PHYSIOLOGY, MORPHOLOGY, EMBRYOLOGY, ETC., OF
MARINE FORMS, PARTICULARLY FISHES**

Because of the varied subjects under this grouping, it would be impossible to treat each one separately, so perhaps it will suffice to say that the library contains numerous papers and books on physiology, pathology, teratology, embryology, anatomy, habits and behavior of animals, parasites, histology, etc.

In addition to the subject classifications as listed above, we have publications and books dealing with other subjects, such as fresh-water fishes and fisheries, fish culture, marine flora, navigation, wildlife and other natural resources. Fish and game laws, reports and magazines issued by the various State commissions in the United States are also on file. The library has a large collection of maps and charts, particularly of the Pacific coastal waters, including those issued by the U. S. Hydrographic Office.

DUCK HUNTING ON THE SAN DIEGO LAKES¹

By E. H. GLIDDEN

Bureau of Patrol

California Division of Fish and Game

When California duck hunting is mentioned most people think of Sacramento Valley rice fields or Suisun marshes. However, some of the best waterfowl shooting in the State is to be had in the extreme south, on Salton Sea and the various reservoirs in San Diego County. These bodies of water are the concentration places for many species of ducks during the winter months, unbelievable numbers of the birds pausing there on their way south to Mexico or ending their migrations at that point.

There are ten large lakes in San Diego County, all of them artificial. The City of San Diego owns six—Barrett, Hodges, Morena, Upper Otay, Lower Otay and El Capitan. Although these are city lakes they are not in the city itself, being located in the hills back of San Diego. The Escondido Municipal Water District owns Lake Wohlford. The other lakes—Henshaw, Cuyamaca and Sweetwater—are owned by private water companies. There has been hunting on all the lakes except El Capitan, which has only recently been formed. Sweetwater Lake has been closed to hunting during the past three years, however. In addition to the foregoing there are several small, unimportant lakes in the county.

Hunting at present is confined to shore hunting, shooting over decoys and just optimistically rowing around after the birds. However, the lakes have derived much of their fame from the "duck drives" which were formerly conducted on them. This was the common method of hunting until it was declared illegal about ten years ago. The practice was first started about 1908 by E. S. Babcock, who was then the owner of the Upper Otay Lake. Guests of his numbering ten to fifteen would start at one end of the lake in rowboats and proceed up the lake in a line. They naturally drove all the ducks ahead of them. The large ducks would leave the lake entirely, but the low-flying ruddies upon reaching the end of the lake would fly back over the boats in an effort to return to the part of the lake they had just been driven off. Then the shooting would begin. Most of the hunters used two guns; when one became too hot from repeated shooting it was doused in the water and tossed into the boat to cool off while the other was being used. As ducks were plentiful, limit bags were the rule. Many coots were also shot. These birds often graced the tables of fashionable hotels and were served as "king rails"—a more attractive name perhaps than mudhen.

In later years duck drives were conducted on all the lakes by private individuals or were organized on the spur of the moment by groups of hunters. It was only on Sweetwater Lake that organized,

¹ Submitted for publication, April, 1938.



FIG. 80. A duck drive at Sweetwater Lake, San Diego County, 1926. The hunters are setting out and have not yet gotten into formation.

commercially conducted drives were held. These commenced about 1916 and were instituted in an effort to reduce pollution of the lake. It was thought that the ducks caused the muddy taste of the water. However, some time later it became known that plant growth caused the taste and it would have been better to leave the birds to eat the plants than to shoot or drive them away.

The Sweetwater drives were held twice weekly, on Wednesdays and Sundays, commencing at 8 a.m. No shooting over decoys was permitted until the drive was over, which was usually about 11.30 a.m.



FIG. 81. A duck drive under way at Sweetwater Lake, 1926.

Over 50 boats, with two or three hunters to the boat, took part in the drive. The boats lined up under the guidance of a captain, who kept them in line, and proceeded slowly up the lake. As soon as the bombardment commenced, most of the large ducks took altitude and left the lake. They spent the morning on the ocean or on the coastal bays, returning in the afternoon after the excitement had died down. As a consequence, most of the ducks killed were ruddies; in fact I would be safe in saying that 75 per cent were ruddies. Coots also took considerable punishment. The average bag per hunter was about 20 ducks (the limit was 25).

When a flock of ducks passed over the line of boats it was greeted with a volley. Everyone raced for the fallen birds, shouting, "my



FIG. 82. The end of a duck drive at Sweetwater Lake. Only a part of the hunters are shown.

duck, my duck!'", and it was a case of finder keeper—the first one to reach a duck claimed it. It has been said that the most successful hunters were those who didn't even shoot—they could get to the down birds quicker. In spite of all the shooting, no serious accidents ever resulted from the drives.

The hunters who wanted to shoot over decoys either had to stand by until the drive was over or take part in it. This was where the most serious abuse of the drive took place. The unscrupulous hunter, who of course was in the minority, would join the drive and kill as many ruddies as he could. These he would either give away or hide. Then he would spend the afternoon shooting over his decoys, and perhaps take a limit of sprig, canvasbacks and other large ducks in defiance of the

law. The decoy hunters shot only the larger ducks, generally ignoring the ruddies. As mentioned above, the duck drives are now a thing of the past. Even if they had not been prohibited, the complete protection given to the ruddy duck by federal regulations in 1932 would have put an end to them.

The City of San Diego has kept records of the hunting on city-owned lakes for a number of years. These records, which have been



FIG. 83. A limit of ducks shot during a drive on Sweetwater Lake. Most of these ducks are ruddies.

made available to us through the kindness of Mr. R. Wueste, in charge of water impounding for the city, give a good idea of the relative amount of hunting from year to year. (See Tables 1 and 2.) Every hunter wishing to shoot on a city lake must first obtain a daily permit from the keeper of the lake. The keeper records the number of permits issued and also checks the kills of as many of the hunters as possible. Actually he can check only the boat hunters, when they return their rented boats, and the shore hunters are seldom checked (they seldom

get many ducks either). Consequently the tables do not show the average kill per hunter, as only part of the total kill can be shown. However, as the checked kill is probably the same relative proportion of the total kill from year to year, the figures presented in table 1 are of value in that they show a steady decline in the number of birds shot.

This drop is due to several causes, all of which are tied in with the big decline in the number of hunting permits issued. A nationwide scarcity of ducks became so serious that the U. S. Biological Survey in 1931 commenced a series of drastic regulations curtailing the kill of waterfowl. These regulations took the form of shorter seasons, shorter shooting hours daily, lower bag limits and complete protection of certain species, among other restrictions. This, along with the increasing scarcity of the ducks, resulted in less people hunting and in less birds per hunter.

The leading species of duck in 1937 was the bluebill, followed by teal. (See Table 2.) This is unusual, as the predominating species is generally sprig, followed by bluebill (since ruddies have been on the protected list). The 1937 season opened very late (November 27), by which time the early arriving sprig had mostly gone on to the south. Ten days before the opening there were thousands of sprig, widgeon and spoonbills on the lakes, but they left for Mexico and did not return until a couple of weeks after the season closed. During the open season most of the ducks to be found on the lakes were bluebills, teal and the protected species—principally ruddies and canvasbacks. Due to the inability of most of the hunters to distinguish the protected species, many of these were accidentally shot (and promptly confiscated). Many of the hunters claimed that an earlier season would do away with the necessity of having a protected list, as most of the nonprotected ducks arrive early and nearly all of the protected birds arrive late.

In spite of the great decline in hunting on the lakes, San Diego County still ranks among the leading duck hunting counties of the State, as shown by the reports given on hunting license applications. Among the 58 counties, San Diego (including San Diego Bay and other tidewater hunting areas as well as the lakes) ranked tenth for both the 1934 and 1935 seasons.

TABLE 1
Waterfowl Kills on San Diego City Lakes^a

Season	Hunting permits issued	Checked kill ^b			
		Ducks	Coots	Miscellaneous ^c	Total
1928-29.....	10,530	59,406	7,169	5	66,580
1929-30.....	10,915	42,091	10,260	16	52,367
1930-31.....	8,077	28,993	3,547	55	32,595
1931.....	4,780	25,253	2,525	47	27,825
1932.....	4,722	14,820	4,683	6	19,509
1933.....	4,501	14,327	6,412	4	20,743
1934.....	3,253	10,648	4,969	59	15,676
1935.....	1,587	5,285	1,746	22	7,053
1936.....	842	1,912	1,062	0	2,974
1937.....	1,237	4,303	1,883	0	6,186
Totals.....	50,444	207,038	44,256	214	251,508

^a Compiled by R. Wueste, in charge of water impounding for City of San Diego.

^b This is the kill of the hunters actually checked by the keepers, not the total kill.

^c Includes geese, jacksnipe, etc.

TABLE 2

Waterfowl Kill On San Diego City Lakes—1937 Season ^a

Species	Morena	Barrett	Upper and Lower Otay	Hodges	Total
Mallard.....	25	7	1	13	46
Gadwall.....	41	76	1	68	186
Widgeon (Baldpate).....	70	8	31	11	120
Teal.....	292	308	364	274	1,238
Spoonbill (Shoveller).....	302	89	73	52	516
Sprig (Pintail).....	453	263	41	111	868
Bluebill (Scaup).....	471	518	243	97	1,329
Total ducks.....	1,654	1,269	754	626	4,303
Coots (Mudhens).....	619	312	483	469	1,883
Total waterfowl.....	2,273	1,581	1,237	1,095	6,186
Total hunters.....	411	240	393	193	1,237
Hunters checked.....	382	240	195	172	989

^a Compiled by R. Wueste, in charge of water impounding for City of San Diego.

RECENT DISASTROUS EFFECTS OF OIL POLLUTION ON BIRDS IN THE SAN FRANCISCO BAY REGION ¹

By JAMES MOFFITT AND ROBERT T. ORR
California Academy of Sciences

Considering the number of oil tankers that have been wrecked in recent years in or close to the entrance to San Francisco Bay and the marked decreases that have occurred in our waterbird populations, the effect of petroleum liberated under such circumstances becomes increasingly important. The devastating effects that crude oil may have on aquatic birds and the degree in which a pollution may destroy numbers of different species, in relation to their habitats and habits were exemplified by a recent disaster that occurred off the city of San Francisco.

On March 6, 1937, the passenger steamer *President Coolidge* struck the Associated Oil Company tanker *Frank H. Buck* in the Golden Gate. Helpless, the *Buck* drifted seaward with the outgoing tide, finally becoming stranded 100 yards offshore, about one-quarter of a mile southwest of Mile Rock Lighthouse. Here the vessel lay, her stern rising and falling in the ocean swells and her hull spewing oil at each heave until she finally broke up several months later.

Aldrich (Bird-Lore, vol. 40, pp. 110-114, 1938) has recently given an account of the effect of this oil pollution, stressing mainly the reaction of various species afflicted. In the present paper the authors have attempted to give data relative to the extent of the oil pollution and habitats involved.

The *Buck* carried a cargo of 65,000 barrels (2,730,000 gallons) of crude oil. From the time of the collision until the boat broke up, this polluting substance was discharged into the surrounding waters. Greatest quantities escaped shortly after the accident and during a heavy storm on March 22, 1937. Following this date there was an obvious lessening in the quantity of escaping oil which was correlated with a corresponding reduction in resulting bird casualties.

The collision was entirely accidental and subsequent conduct of the Associated Oil Company and authorities in charge of pollution matters left nothing to be desired in their efforts to alleviate conditions. Indeed, the episode can only be classed as a most unhappy accident, costly to those financially involved as well as to innocent victims, including boat and littoral property owners, aquatic bird populations and various forms of marine life.

The area covered by oil pollution, so far as could be ascertained, extended from Point Reyes, south to below Half Moon Bay or along about 55 miles of coast line. Oil pollution was very noticeable in the vicinity of the Lightship, 10 miles offshore from Mile Rock Lighthouse,

¹ Submitted for publication, May, 1938.

according to Captain Louis L. Lane, bar pilot. In the vicinity of the Farallon Islands, however, approximately 28 miles offshore, unusual quantities of oil were not apparent, according to Oliver R. Berg, keeper of the Farallon Light Station. It is hence probable that severe oil pollution did not extend more than from 15 to 20 miles to sea opposite the Golden Gate. Little oil entered San Francisco Bay, except for a narrow strip reaching at least as far as Alcatraz Island shortly after the collision, and minor pollution on some of the beaches. Bakers Beach, however, between the wreck and the Golden Gate, was in a constant state of pollution.

Our attention was first drawn to the effects of this disaster upon bird life on the occasion of the senior author's visit to Tomales Bay,



FIG. 84. The Associated Oil Company tanker *Frank H. Buck*, wrecked off the Golden Gate, March 6, 1937. Photograph supplied through the courtesy of the *San Francisco Chronicle*.

Marin County, on March 14. Here, not more than 10 surf scoters (*Melanitta perspicillata*), 6 western grebes (*Aechmophorus occidentalis*) and 3 common loons (*Gavia immer immer*), out of hundreds of the former and dozens of the two latter species present, were observed to be affected by oil. Since the mouth of Tomales Bay lies well northeastward of Point Reyes its waters were free from pollution; consequently the affected birds must have encountered the oil somewhere to the south and flown to Tomales Bay. Most of the victims were but lightly affected and had normal control of their faculties. A grebe and a scoter, however, were so oil-besmirched as to be virtually helpless. Reports of other observers indicated that at no time during

the following three months were there many oil-soaked birds on this bay. This tends to show that either the individuals of species affected in the main area of pollution to the southwest do not visit Tomales Bay, or that birds that had encountered much oil were unable to travel this far. On a visit to this bay on June 25, 1937, no birds that were incapacitated by oil were encountered by the senior author.

After noting the oil-sick birds on Tomales Bay on March 14, 1937, the senior author visited Bolinas Bay and Lagoon where conditions were found to be very bad. On driving along the $3\frac{3}{4}$ miles of road skirting the eastern shore of the lagoon literally hundreds of dying birds were observed, but very few individuals were seen dead at this time. Eared grebes (*Colymbus nigricollis californicus*) appeared to outnumber affected individuals of all other kinds combined, although at a later date in this same locality western grebes predominated. At several places where pickle-weed (*Salicornia ambigua*) approached the water's edge, clumps of this growth appeared to be moving. Upon close inspection this apparition was seen to consist of the heads and necks of dozens of these birds ineffectually attempting to remove oil from their feathers with their bills. The lesser numbers of affected birds consisted mainly of western grebes, loons and ducks of several species. Lack of time prevented a count being made of the doomed birds, a circumstance which has since been regretted. Although several species of gulls were fairly common in this vicinity but a single western gull (*Larus occidentalis occidentalis*) was found to be affected. Subsequent observations at various localities where oil pollution was severe indicated that gulls were relatively immune from this source of danger. This was attributed largely to their habit of not resting to any great extent on salt water. Rocks, piles, islets, sandy beaches and even freshwater lakes are used for this purpose by gulls to a much greater extent in this region. Much of their food, likewise, is gleaned from the surface of the water while on the wing.

At Stinson Beach the senior author met Paul A. Shaw, chemist in charge of the pollution detail for the California Division of Fish and Game, who stated that there was already so much oil on the waters of Bolinas Lagoon that little could be done to remedy matters at present. Ifad time permitted, Shaw said, it might have been possible to have protected the lagoon by placing a log boom across its narrow entrance. He also asserted that everything possible was being done to correct conditions at the wreck, the source of trouble, but that heavy seas hindered salvage and protectionary efforts. It seemed that clean-up work along the beaches and the humane dispatch of helpless birds comprised the extent of assistance that could be rendered.

Returning from Sausalito to San Francisco by ferryboat on the evening of March 14, about midway across San Francisco Bay, the senior author observed an intertidal streak of oil, about 60 feet in width, extending from the Golden Gate at least to Alcatraz Island. As food refuse was likewise concentrated in this ribbon of greatest danger many gulls were seen feeding here, mostly dipping, petrel-like, to snatch morsels of food from the filthy mass. Occasionally individuals were seen to alight and a number of the gulls observed flying overhead were partly coated with oil.

The following day the authors decided to take advantage of the opportunity afforded by this catastrophe to salvage avian skeletal material. With this purpose primarily in mind, joint visits were made to the beaches of San Francisco and San Mateo counties on March 16, to Half Moon Bay on March 22, and to Bolinas Bay and Lagoon on March 23, 1937. It has since been regretted that, on these occasions, more careful notes were not taken of the total number of affected individuals and kinds encountered in relation to the areas traversed.

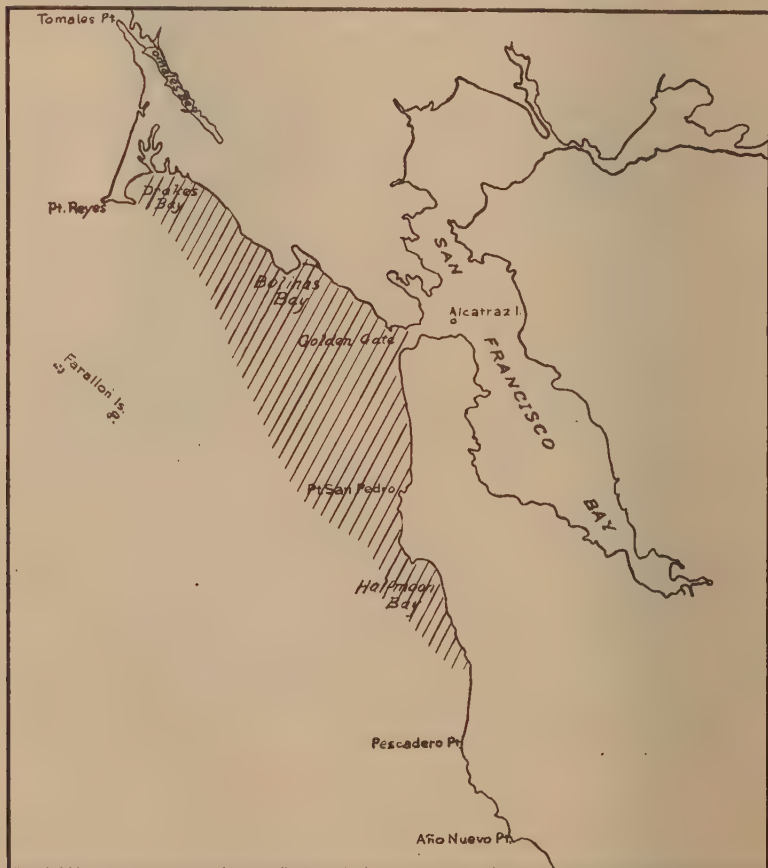


FIG. 85. Map of the San Francisco Bay region with shaded portion showing the extent of oil pollution as a result of the wrecking of the Associated Oil Company tanker *Frank H. Buck*.

In the course of our ocean beach patrols individuals of the following species were found dead, presumably as a result of contact with oil: red-throated loon (*Gavia stellata*), Holboell's grebe (*Colymbus grise-gena holboëllii*), western grebe, white-winged scoter (*Melanitta fusca dixonii*), California murre (*Uria aalge californica*) and marbled murrelet (*Brachyramphus marmoratus marmoratus*). Only four marbled

murrelets were noted in all. The rarity of members of the family Alcidae among the oil victims, except for California murres, and absence of any representatives of the order Procellariiformes was a matter of surprise, as at this season we had reason to believe that several species of auklets and murrelets as well as petrels and shearwaters were common offshore. The almost total absence of these forms, save for the murres, seemingly indicated that the other species range farther from shore than the oil extended.

The murres predominated greatly among the ocean beach victims as was evidenced by a census made by Orr just north of Half Moon Bay beach. Here 30 carcasses were counted along a littoral sand beach over a distance estimated to be one-quarter of a mile in length. Assuming that this section was average for the polluted coast line of about 55 miles, no less than 6600 murres fell victim to the catastrophe. That this estimate is conservative, in face of the fact that currents may conceivably have (unknown to us) concentrated the bodies at this point or the birds been especially abundant off this locality, are the considerations that we found similar aggregations of corpses of this species on other beaches, that Orr's census represents but one day out of many of peril which existed for the birds, and the count was made before the end of the danger. Furthermore, the bodies had been washed upon the beaches for some time prior to our visit and many carcasses may have either been buried out of sight in the sand or removed by several causes. It would seem that the loss of this number of murres should seriously affect the status of the already sadly depleted colonies of the species inhabiting this portion of the California coast. Mass numbers on the breeding cliffs comprise the murres' best method of protection against their arch enemy, the western gull. Information supplied by Berg, however, indicates that no diminution is apparent in the numbers of murres at that insular colony, although Captain Lane assures us that murres are now relatively scarce between the Golden Gate and the Lightship, some ten miles offshore, where, prior to the time of the wreck, they were very numerous.

The absence of most species of ducks, with the exception of scoters, and the scarcity of most of the grebes and loons among the avian oil victims noted along the ocean beaches are explicable by reason of their more estuarine habits. Sanderlings (*Crocethia alba*) are common along the beaches, especially at Half Moon Bay and their custom of feeding in the shallow waters of receding waves would seem to subject them to great danger from the oil. Many individuals of this species were observed to be stained with oil, but as none were found dead it appeared that the species was able to withstand this hazard. Snowy plovers (*Charadrius alexandrinus nivosus*) were common along the dry, sandy portions of Half Moon Bay beach, but apparently were unaffected by the oil which in places covered the sands in large, asphalt-like masses.

Quite a different bird fauna was represented by the oil victims found at Bolinas Lagoon on March 23, 1937. This shallow, sand- and mud-bottomed lagoon is attractive to species preferring relatively quiet, shallow waters as is shown by the following list of species and approximate number of dead individuals found by us along the $3\frac{3}{4}$ miles of eastern shore line: common loon, 2; red-throated loon, 12; eared grebe, 12; western grebe, 200; Farallon cormorant (*Phalacrocorax auritus*

albociliatus), 1; scaup duck (both lesser and greater), 10; American golden-eye (*Bucephala clangula americana*), 3; white-winged scoter, 60; surf scoter, 10; ruddy duck (*Oxyura jamaicensis rubida*), 25; red-breasted merganser (*Mergus serrator*), 3; glaucous-winged gull (*Larus glaucescens*), 1.

Maritime species such as murres were naturally not expected to be found here. The absence of the Pacific loon (*Gavia arctica pacifica*) and scarcity of the common loon are explicable by the preference of these species for deeper waters. The same reason accounts for the absence of Holboell's grebe. Ducks and grebes, relative to numbers present, appeared highly susceptible to the oil hazard. Curiously, black brant (*Branta bernicla nigricans*) seemed largely immune to the lethal effects of crude oil. Several hundred of these birds were observed standing on a sandbar near the mouth of the lagoon. Close scrutiny with field glasses failed to reveal the presence of oil on the feathers of these birds, although a few brant had previously been seen to be slightly oil-stained on Tomales Bay. The escape of this species from the oil peril is difficult for us to reconcile in view of its largely aquatic habits.

SUMMARY

Oil pollution of coastal waters contiguous to San Francisco Bay, the result of a shipwrecked oil tanker, presented unusual hazards to the avifauna of the areas affected during March and April, 1937. Pollution extended along 55 miles of coast line, centering at the Golden Gate and reaching from 15 to 20 miles out to sea. Its effects were felt not only by species of birds occurring along the open coast but also by those forms inhabiting shallow bays.

Among the offshore species of birds, California murres suffered most and the incident may have inflicted disastrous losses among proximal nesting colonies. Scoters and western grebes were species next in order affected. Offshore ranging forms such as murrelets, auklets, shearwaters and petrels were apparently spared because the oil did not extend sufficiently far from shore to embrace their habitats. In the quiet bays, western grebes, white-winged scoters, ruddy ducks, eared grebes and red-throated loons suffered most in the order named.

Although several kinds of gulls were commonly observed in both habitats, so few were found incapacitated by oil that it was concluded that these birds escaped largely by reason of their feeding and resting habits.

TUNA TAGGING¹

By H. C. GODSIL

California State Fisheries Laboratory

Division of Fish and Game

In the tuna fishery, as in all our marine fisheries, the problem of scientific management consists essentially of determining the maximum annual yield which may be taken indefinitely. This maximum annual yield is limited by the size of the stock and the annual increase due to successful spawning. In order to maintain a fishery at its most prolific level, it is therefore necessary to establish a balance between the amounts added to the stock and the tonnage taken from the stock, and this obviously necessitates some absolute or relative measure of the three essential quantities involved, the annual increment, the stock and the catch. Concerning the latter, we have complete and detailed statistics dating back to the origin of the fishery; but about the size of the stock of tuna and its annual increase we know very little. To supplement this deficiency the present investigative program was initiated, covering in so far as this article is concerned, only the combined fishery for yellowfin tuna and skipjack.

The main objective of this investigation is to determine the nature of the stock upon which the industry depends. In the earlier years the bulk of the tuna catch was taken in the second half of the year, with the heaviest fishing in August, September and October. Through the remainder of the year catches were light, because fish were not available. Subsequently, larger boats discovered that during these lean months tuna abounded farther south, in waters hitherto unfished; whereupon the catch has since doubled, and deliveries have become fairly uniform throughout the year. Do these facts mean that the fleet is following migratory schools throughout the year, thus increasing the intensity of fishing many fold; or do they indicate that the vessels have discovered virgin grounds with distinct and separate populations, yielding a greater total catch with no increased intensity of fishing? Is this increased catch, in other words, being taken from the original stock of migratory fish, or is it coming from a separate and different stock confined throughout the year to the newer fishing grounds? This question must be answered if there is to be intelligent administration of the tuna fishery; and the answer is being sought in a careful comparison of fish from the different areas and in a tagging project.

In animal communities we find frequently that slight differences in physical characters exist within a single species, dependent either upon inheritance or upon varying environmental factors operative during critical stages of individual development. Where there is unrestricted interbreeding, and where spawning is at one time and in only one area, and where the young are raised in one area and at one time, there should not be any discernible differences within the stock. If,

¹ Submitted for publication, March, 1938.

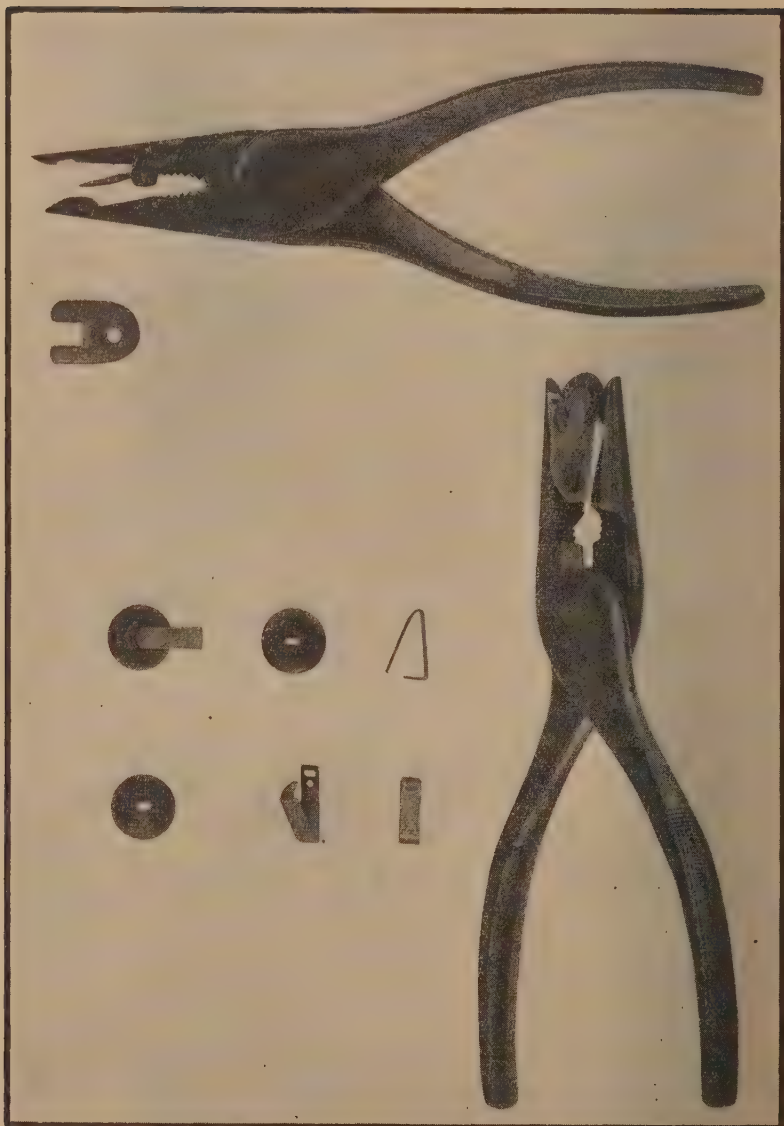


FIG. 86. The tuna tag and the modified pliers used in attaching the tag to the fish.

however, distinct populations exist, spawning at varying times and in different areas, one may justifiably expect to find physical differences in the different populations. Such differences are slight, often being less than the range of variation among the individuals of a single sample, so that it is necessary to examine large numbers of fish from the different grounds and subject the resulting values to a biometrical analysis. The results that emerge often give a clue that goes beyond the immediate problem, a clue that not infrequently throws light upon the complex life-history of the species.

The second approach to the study of the stock of tuna consists of liberating marked fish in different areas and awaiting the recovery of these marked fish to interpret their movements. Tuna tagging, ostensibly the subject of this article, was started at the inception of the tuna investigation, but because of the innumerable difficulties involved, progress has been slow. The tag finally adopted, after much forethought and some experiments, consists of two parts—a sterling silver strap and a colored celluloid disc. The strap serves merely to retain the disc on the fish, whereas the celluloid disc (colored red) is used to make the tag more conspicuous in order to facilitate recovery. The disc bears a serial number and a request to the finder to notify this Laboratory of his catch. The tag is applied to the fish in a single operation by means of a modified pair of "long nose" pliers adapted to hold the tag and lock or crimp it in place upon the fish. The tag and pliers are illustrated in figure 86. All tuna are tagged upon the preoperculum, which is the forward part of the gill cover.

In operation, two or more pairs of pliers are kept loaded and ready at hand. When a fish is caught, the arm of the pliers bearing the tag is slipped beneath the preoperculum, carrying the straight arm of the strap with it. The entering point of the arm is ground to a tapered edge so that it is possible to insert the arm directly under the preoperculum without otherwise lifting the latter. The pliers are thrust forward until the angle of the tag approaches within three or four millimeters of the opercular margin, where the strap (bearing the disc) is locked in place by pressure upon the handles of the pliers. This locking is accomplished by forcing the prong of the strap through the opercular bone and then through an aperture in the opposing arm. As the prong traverses this aperture, it strikes a shallow groove in the arm of the pliers, which deflects the point backwards and upwards, effectively locking the strap to and through the preopercular bone. The number of the tag is recorded with the size of the fish, which is then lifted from the deck and dropped overboard.

All fish are measured in order to secure their rate of growth. By measuring the fish when it is tagged and again upon its final recapture, the growth in this interim may be determined, and when sufficient records accumulate, the growth curve for the species can be established. In the case of the tuna this is the only completely satisfactory means at present available for determining growth rate. Bone and scale markings fail, due most probably to the uniform conditions under which the tuna live, and the consequent lack of the seasonal rhythm so characteristic of the temperate zones.

The entire operation takes only 15 to 20 seconds. It is necessarily fast because the tuna is a powerful antagonist that will fatally injure itself in the struggle if left too long on deck. Fortunately,

when a tuna is first landed (by commercial hook and line methods) it gives a momentary flurry and then for 30 to 60 seconds remains flexed, tense and motionless. It is in this interval that the tagging must be done, for when the ensuing struggle begins it is impossible to hold even a 10-pound fish still enough to apply the tag. Moreover, in the struggle the fish begins to bleed about the gills and this weakens it to such an extent that its survival is extremely doubtful. A stunned or weakened fish on the tropical grounds is devoured by sharks almost instantly. Only vigorous uninjured fish are tagged.

Of the 4000 yellowfin tuna and skipjack that have been tagged, the large majority have been caught and tagged from commercial boats. Up to the present time this has been the only available means of securing fish from the distant grounds. Generally two investigators from the State Fisheries Laboratory accompany a commercial boat, and buy the fish from the fishermen at a previously accepted price. A tagging station is selected on the boat with some care. This must be located adjacent to the gratings where the fish are caught, yet beyond the range of flying hooks and falling fish, because the tagging is done as the commercial catch is made. On the one commercial boat on which all the tagging has thus far been done, this tagging station was located on the stern on the starboard side. On this vessel the crew habitually fish on the port side with two men in a stern grating on that side also. Whereas the remainder of the crew land their fish on the deck in the alleyway between bait tanks and rail, the two men in the after grating land their fish on the stern. This was an ideal location, because the starboard side of the stern, while not in use, nevertheless received a supply of freshly caught fish. In practice the fishermen on the stern would land their fish gently on deck when the tagger was ready, instead of in the customary commercial manner. The barbless hooks universally used are readily disengaged with little or no injury to the fish. Holding the fish with one hand, the operator then applies the tag to the right side of the fish, the number of the tag and the size of the fish being recorded by the assistant. All tuna are tagged upon the right side because in the majority of canneries the fish are cleaned with the right side up. If, therefore, a tagged fish escapes notice on the boats, it has a greater chance of recovery in the cannery if the tag is upon the upper side.

Tagging on the commercial boats is, to say the least, an interesting experience. It is a thrill to handle these grand and powerful fish. When the fish are biting fast, the decks of a tuna boat are a veritable bedlam, and the job of the taggers is a wet and gory one. Working amidst a seething mass of struggling fish, one is literally drenched in a flying spray of water, blood and slime. Blinded by this, it is at times impossible to see the fish that one is trying to tag. The absence of freeboard adds further to the confusion; for frequently with a load of fish on deck, the weather rail will roll beneath a wave, and on the return roll to leeward everything ends up in the scuppers, with the fish actually swimming along the deck—sometimes with the tagger hanging on.

The number of fish thus tagged upon a single trip has varied from 500 to 1400. Success is purely a matter of chance, depending primarily upon the size of fish taken and the rate at which the catch is made. For various reasons, the tagging thus far has been limited, to a

large extent, to fish less than 20 pounds in weight. If therefore the commercial load consists entirely of large fish, very little tagging can be done. When the boat is loaded rapidly with large daily catches, fewer fish are tagged than when the catch is slow and steady. Whereas this is the only means now available of tagging on the distant grounds, it is slow and time consuming for each trip thus far has averaged 60 days. An additional disadvantage of the commercial boats is the fact that one never knows the destination. The boats go wherever fish are most available and not where the tagger wants to work. Thus, plans provide for tagging at the Galapagos Islands but so far our investigation has failed to reach this destination.

Whenever possible, *i.e.*, when tuna are in local or adjacent waters, the patrol vessels of the Division of Fish and Game are used in the tagging work. Here, the advantage of complete control over the movements of the vessel is offset by lack of proper facilities for catching fish. Lacking bait capacity and the specialized features of a tuna boat, it is necessary to catch the tuna on lures trolled astern. This method of fishing is infinitely slower and more uncertain and in consequence the number of tuna tagged from our own boats is not appreciable. The tagging procedure is essentially similar.

The lack of a suitable research vessel has greatly impeded the tuna investigation. The need has long been realized and plans for such a boat have been prepared. It is to be hoped that she will be acquired in the near future. Pending the construction of the vessel, the tagging work has been more or less held in abeyance.

At the outset of the tuna investigation, it was planned to tag a total of 10,000 fish in three fishing areas. Approximately one-third were to be tagged off the coast of Lower California, one-third off the coast of Central America, and the remaining third at the Galapagos Islands. The lesser distinct fishing areas, such as the Revilla Gigedo Islands, Clipperton Island and Cocos Island, were to be covered later. Of this plan the tagging off the mainland of Central America has been completed, though unfortunately there has been too much concentration in Costa Rican waters to the neglect of other grounds. The work off the coast of Lower California is well under way though by no means complete, whereas the tagging at Galapagos has not been started. In addition, about 140 fish were tagged at Cocos Island. From results to date it is now clearly apparent that far greater numbers must be tagged than originally planned, but the extension of this work must await the acquisition of a suitable boat.

Although 4000 fish have already been tagged, no recoveries have as yet been made. Whereas this has given rise to apprehensions concerning the fate of tags and tagged fish, it has in no way discouraged the tagging program. Every effort has been made to eliminate possible sources of loss; and there is reason to believe that the tag in use and the tagging procedure are in general satisfactory. The lack of recoveries is no doubt due to two major factors. Of these, the tremendous extent of the fishery and the small number of tags out is probably the most important. Thus, if the 4000 tags were scattered uniformly along the straight course covered by the tagging work, there would be roughly only one tagged fish per linear mile!

The second difficulty pertains to recovery. Returns depend entirely upon the tag being seen; and where large quantities of fish

must be handled rapidly on the boats, no effort can be made to examine individual fish. Although this handicap is inherent, every effort has been made to circumvent it. The tagging program has been widely publicized in the industry and the cooperation of the fishermen solicited. A reward of \$1 a tag is offered to the fishermen, and \$0.50 per tag to the workers in the cannery. Unfortunately, magnetic tags, such as are used for mackerel and sardines can not be used profitably with tuna. To be of any value, it is necessary to know where the tag was taken; and in the majority of cases this could not be ascertained with the use of a magnetic tag because the tuna boats fish over extensive and widely scattered areas almost every trip, and the limited knowledge that a tag was recovered by a specific boat would yield no information of intrinsic value. Tuna tagging must therefore employ a "visual" tag.

The ultimate success of the program need not be doubted; for it will be realized when a sufficient number of fish have been tagged. In consequence the tagging program will be pursued relentlessly until we have determined the movements of the tuna, providing that the value of the work justifies the time and effort expended. For it must be borne constantly in mind that tuna tagging, spectacular though it may be, is merely a means to an end. The ultimate goal of the investigation is a sufficient understanding of the fishery in all its ramifications to enable scientific management, and the necessity or justification of the tagging program—and indeed all biological work—must be evaluated in terms of this final goal.

TUNA CANNING METHODS IN CALIFORNIA¹

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INTRODUCTION

The tuna canning industry in California dates to 1907, when, following a shortage of sardines, A. P. Halfhill experimented with a tuna pack in order not to suffer closing of his plant. It was he who developed the present method of packing, and through 1911 he was the only producer. In 1912, other concerns entered the field and since that time demand and pack have increased enormously.

Canning methods, discussed in detail in the following pages, may be briefly outlined thus: The fish, upon arrival at the canneries, are eviscerated immediately unless frozen, in which case they must be allowed to thaw. Butchered, the fish are stacked in trays contained in a mobile rack, several of which are wheeled into a large iron steam cooker. Here the fish are cooked at a minimum temperature of 214 degrees F. for two to eight hours, time dependent primarily upon size. After cooking, women workers remove head, skin, bones and dark meat, leaving only four long strips of white meat. These strips are sliced into appropriate lengths, and then packed into cans by hand. Salt and oil are added, and the tins sealed. Vacuum closing machines are in common use, though some plants prefer to pass the tins through a short exhaust box (wherein they are exposed to live steam at no pressure), after which they are sealed. Two plants make no particular attempt at obtaining a vacuum, simply sealing the filled cans. Retorting under conditions of time and temperature prescribed by law completes the canning process.

THE INDUSTRY

Practically the entire California tuna pack is processed by some dozen plants situated in San Diego and the Los Angeles Harbor area (Long Beach, Terminal Island and Wilmington). The Los Angeles Harbor area is commonly referred to as the San Pedro area although no plants are located in San Pedro proper. Most of these concerns handle sardines and mackerel as well as tuna. In San Diego sardines and mackerel are of minor importance but in the Los Angeles plants they comprise the bulk of the pack. San Diego, with its large landings of yellowfin tuna and skipjack, is the leading tuna port, even though nearly twice as many plants pack tuna in the Los Angeles district.

¹ Submitted for publication, May, 1938. Although space forbids naming all of those representatives of the industry whose cooperation and assistance made possible this report, the writer wishes at this time to express to them his thanks. He is especially grateful to Mr. Alfred Luthi of the American Can Company, Los Angeles, and to Mr. Clifford S. Yeoman of the Coast Fishing Company, Wilmington, who not only extended every courtesy but who was kind enough as well to read and criticize the manuscript. The writer alone, however, is responsible for all statements contained in the report. All photographs by Donald H. Fry, Jr.

Albacore, bluefin and bonito are canned primarily at Los Angeles as is all imported tuna. Most of the yellowtail packed is handled in San Diego. In 1937, some 101,000,000 pounds of tuna and 5,000,000 pounds of yellowtail were landed in San Diego, while 71,500,000 pounds of tuna (including 10,500,000 pounds of Japanese fish) and 500,000 pounds of yellowtail were landed in the Los Angeles area. A summary of tuna and yellowtail landings for 1936 and 1937 is given in table 1.

Present importance of the tuna industry may be seen from the fact that landings of the several species are first in value and second in tonnage in the State's fisheries.

TABLE 1

Tuna and Yellowtail Landings in San Diego and Los Angeles Regions, 1936-1937

Table includes deliveries to fresh fish markets but these are small except in case of yellowtail. Importations from Japan, Northern California, Oregon and Washington, include only fish used for canning.

Species	1936			1937		
	San Diego	Los Angeles	Total	San Diego	Los Angeles	Total
Albacore.....	2,403	898,871	901,274	326,370	1,107,693	1,434,063
Albacore (Northern California, Oregon and Washington).....		41,152	41,152		1,721,759	1,721,759
Albacore (Japanese).....		1,499,233	1,499,233		1,546,939	1,546,939
Bluefin.....	1,284,743	17,644,884	18,929,627	1,399,151	11,287,047	12,686,198
Bonito.....	2,330,295	4,881,003	7,211,298	2,636,672	5,151,066	7,787,738
Mebachi (Japanese).....		20,370	20,370			
Oriental (Japanese).....		745,052	745,052		523,632	523,632
Skipjack.....	17,558,476	9,447,622	27,006,098	31,520,010	15,584,061	47,104,071
Skipjack (Japanese).....		2,264,925	2,264,925		7,594,903	7,594,903
Yellowfin.....	58,051,689	20,300,890	78,352,579	65,405,461	26,116,802	91,522,263
Yellowfin (Japanese).....		8,628	8,628		884,148	884,148
Total tuna.....	79,227,606	57,752,630	136,980,236	101,287,664	71,518,050	172,805,714
Yellowtail.....	7,932,805	2,147,706	10,080,511	4,826,612	544,369	5,370,981

THE FISHERY

The tuna canning industry is dependent in the main upon catches made by the San Diego-San Pedro tuna fleet and delivered by these vessels to the canneries. Four species form the basis of the true tuna pack: yellowfin tuna (*Neothunnus macropterus*), bluefin tuna (*Thunnus thynnus*), skipjack or striped tuna (*Katsuwonus pelamis*), and albacore (*Germo alalunga*). A fifth tuna, the bonito (*Sarda* sp.) and yellowtail (*Seriola dorsalis*) are packed tuna style but can not be marketed as "tuna." In addition, a small amount of mackerel (*Pneumatophorus diego*) is canned tuna style at San Diego.

Yellowfin and skipjack constitute a single fishery and are taken throughout a vast area extending from southern California to the equator. Of the two, the yellowfin is the finer fish and constitutes the backbone of the industry. Both species are taken throughout the year. A detailed account of this fishery is given by Godsil.² Bluefin are taken primarily from June to September between Guadalupe Island off the Lower California coast and Point Conception. Albacore, once of great importance, now makes a minor contribution to the total catch. It is taken mostly off southern California, though some is generally landed

² Godsil, H. C. The high seas tuna fishery of California. Calif. Div. Fish and Game, Fish Bull., no. 51, 41 pp., 1938.

during the fall at Monterey, while a large run occurred off the Oregon coast in the fall of 1937. Some canning of albacore has been done at Monterey but the great bulk of the catch is shipped to Los Angeles for processing. The 1937 Oregon catch was likewise shipped to southern California, but it is understood that some northern canneries have installed equipment for albacore canning in anticipation of continued northern runs. Bonito is of minor importance. It is taken off the Lower California coast throughout the year and off southern California during the late summer and fall. State law prohibits the canning of yellowtail taken in California waters. Therefore, the entire cannery catch is taken below the international line.

Certain of the San Pedro canneries depend upon imported frozen tuna from Japan for a part of their pack. Albacore and skipjack, comprising the bulk of the imports, are augmented with lesser amounts of oriental tuna (*Thunnus orientalis*), yellowfin, and occasional other species. Importations started in 1927. Until 1933, albacore was delivered in the greatest quantity, reaching a peak of some 7,000,000 pounds in 1930. Skipjack importations began in 1933 and now account for the greatest poundage, some 7,500,000 pounds being landed in 1937 as against 1,500,000 pounds of albacore. (See table 1.)

Total importations, averaging some 4,000,000 pounds a year through 1936, leaped to 10,500,000 pounds in 1937, which still is but a small proportion of the 173,000,000-pound grand total landing for the year at the two ports. Prior to 1935, small amounts of albacore and skipjack were imported from Hawaii as well. Some operators do not like the imported fish; others feel that the Japanese skipjack arrive at the cannery in better shape than those taken by the California fleet. Importations were first occasioned by expansion of the market, at which time small operators found this procedure more economical than financing tuna vessels.³

UNLOADING OF TUNA AT THE CANNERIES

Methods of unloading vary with the physical situations of the plants. At Terminal Island and in Wilmington, public roadways pass between the plants and their docks. The Terminal Island plants utilize large iron push carts; these are lowered into the holds of the boats where they are filled and then raised back to the street, using the boats' boom and winch. A few plants unload small albacore boats onto wooden conveyors which run from water level to the cannery, passing underneath the roadway. Scales at the Island plants are located just inside the cannery entrance. The Wilmington plant uses a wooden conveyor which brings the fish up to the street level, dropping them into carts similar to those used at Terminal Island. The scales again are located in the cannery. In all of these plants, the fish are dumped onto the cannery floor where they are sorted as to size and condition.

Long Beach and San Diego plants have their own docks. In San Diego, the weighhouse is situated in a tower beside the dock. A container is lowered into the hold, a winch and boom on the dock being utilized. When filled, the container is lifted to the weighhouse, the

³ Godsil, H. C. The five tunas. Calif. Div. Fish and Game, Fish Bull., no. 49, pp. 24-33, 1937.



FIG. 87. Thawing tuna on the cannery floor.

weight noted and the fish dumped either into a flume or onto a wooden conveyor, which carries them directly to the butchering tables in the plants. Frozen fish are removed at the end of the conveyor; they may be diverted to other conveyors which carry them to thawing tanks, or simply lifted from the head of the butchering table. Badly mutilated fish are removed at the same time. A Long Beach company uses a wooden belt conveyor running from beneath the dock at the level of the vessel's deck to the entrance of the plant. Here the fish fall into iron carts similar to those used at Terminal Island. Whatever the method of unloading, a representative of the crew will always be found at the scales checking the weight.

The fish are washed as soon as unloaded. When a flume system is used, washing occurs during transit to the plant. Some plants using wooden conveyors have a shower system over a portion while others simply wash the fish with hoses when they are dumped on the cannery floor.

THAWING

Fish arriving in a frozen state must be permitted to thaw until they are soft enough to butcher and cook. Cooking of a "hard" fish will result in the explosion of ice crystals in the cells with resultant injury to the tissues. Opinion differs as to the proper method of thawing. In the San Pedro district, it is customary to leave the fish on the cannery floor, washing them continually, occasionally or not at all. Assortment as to size is generally made at this time. (See Fig. 87.) Some plants place a part of the fish in tanks filled with sea water and permit them to thaw there. Where space is limited, frozen fish may be heaped on the floor rather than placed in a single layer. In San Diego, thawing tanks are now in general use. The tanks, built of wood or concrete, hold from one to five or more tons of fish. The most elaborate system is found in a plant which has a conveyor running from the end of the unloading flume to the numerous thawing tanks. The fish can be diverted to the various thawing tanks as desired. When thawed, a trap at the bottom of the tank is opened and the fish are returned by flume and conveyor to the head of the butchering table. Other concerns divert the fish by flume or carry them by hand to the tanks. One plant in the San Pedro region places its fish in racks (later used in the steam cook) in which they are allowed to thaw. The fish are not washed while thawing, as the operators of this cannery feel that any speeding of the natural rate of thaw is harmful. They are, however, washed before they are racked. This plant and one other in the same area have experimented with thawing tanks but feel them unsatisfactory.

The San Diego plants using tanks feel that they get a thorough and even thaw and in much less time than is possible by any other method. However, operators in San Pedro who have tried tanks and discontinued their use claim that the thaw is not even; that where the outer layers of flesh are soft, the deeper muscles may still be frozen and that there is a tendency for the outer layers to become somewhat mushy—a condition which has caused rejection of some fish by State officials on the grounds of spoilage. Plants continuing to use tanks claim no such difficulties. It is maintained that the dissatisfied operators who used makeshift tanks with no provision for circulating water should not compare their results with the more refined systems in use at San

Diego. There are objections to thawing on the cannery floor, in either one layer or in heaps, for the following reasons: It is claimed that the top of the fish thaws more rapidly than the side against the concrete cannery floor, that streams of water are too often irregularly applied, causing a more rapid thawing of some fish, and that when the fish are piled, those on the outside thaw much more rapidly than those at the center. Further, in hot weather there is danger of the outside of a fish spoiling while the inside is still hard. As even a thaw as can be obtained is essential; the fish must not stand too long after thawing, and frozen or partially frozen fish will be spoiled in the steam cook. The most even thaw obtainable is claimed by the plant which places its fish in racks; this concern butchers and washes the fish as soon as



FIG. 88. Butchering yellowfin. The butchers slide the eviscerated fish into the tub where they are washed by the man at the left. The man in the left background racks the fish preparatory to the steam cook. Note the filled carriers in the background.

they are softened, but then takes the added precaution of delaying the steam cook until the fish reach a body temperature of 40 degrees F. This may take eight to twelve hours after butchering. They feel that the longer time required by this method is repaid with a finer grade of meat after the cook.

Time of thawing is highly variable and depends upon the method used, the size and condition of the fish, weather conditions, and the attitude of the plant in question as to what constitutes a proper thaw. In a thawing tank, a small fish may thaw sufficiently in two hours, whereas a fish of medium size requires three hours and a large fish, four to seven. Estimates of time required in the air vary greatly. In moderately warm weather, a small skipjack may thaw on the floor in four hours. It may stand overnight or up to 15 or 18 hours. A moderate sized fish may be left 12 to 36 hours, whereas a large one may require up to 48 hours. The process is accelerated if the fish are washed while thawing.

BUTCHERING

Unfrozen fish are butchered upon their arrival at the cannery; those frozen must perforce await thawing. The butchering crews are made up primarily of Filipinos in the San Pedro area and of Mexicans in San Diego. A simple longitudinal cut is made upon the right side of the body. The viscera are cut free at both ends of the body cavity, sometimes by the man making the initial incision, sometimes by a worker next to him. Head and gills are not removed. The fish are washed and placed in wire trays which fit in turn into mobile racks which are wheeled into the cooker. Six small fish will fit into one tray of standard size, 30 by 15 inches. Trays 36 and 42 inches in length are sometimes used to accommodate longer fish. When fish are too long for the trays, a section is cut from the tail either with a saw or with the regular butchering knife and placed beside the fish in the tray or in another basket. (See Fig. 89.) This piece may be removed either before or after butchering. The fish are placed in the trays with the incision down to facilitate drainage during the cook.

Of the viscera, the liver is usually saved and sold to various pharmaceutical houses for manufacturing into medicinal oil. The balance of the viscera receives a short steam cook and is then sent to the reduction plant.

Although the actual process of butchering is nearly the same throughout the industry, the butchering tables are of two types. The older form is a mobile table with a tank, located either in the middle or at one end, in which the fish are washed. (See Fig. 88.) This type of table is in use in all of the plants in which situation or choice makes it necessary to dump the fish from carts. San Diego operators utilize a wooden belt conveyor at the end of the flume or conveyor from the weighhouse. A man at the head of the conveyor places the fish on the belt right side up, head toward the center, at an angle of somewhat less than 45 degrees. The butchers stand along the belt, the speed of which is regulated according to the number of fish the cannery feels they should be able to prepare carefully. Beyond the butchers a man washes



FIG. 89. Cutting the fish to fit the racks. These fish are of great size; often the butchers can remove a piece of sufficient length with their knives.

the eviscerated fish, using a short hose for this purpose. He also removes any adhering bits of viscera. At the end of the belt, the fish are removed and racked. Recently, one plant has added a worker to each line whose duty it is to wash out the gills and mouth of each fish before it is cleaned. He is equipped with a short hose with a nozzle cut down to give considerable force to the flow of water. The tip of the nozzle is slipped under the gill cover and the water turned on for a second or so as the fish passes by on the conveyor.

Whatever the method of unloading, thawing and butchering, the finest pack will in general result from the fish which have been handled the least and with the maximum of care. Rough handling of a fish, frozen or not, will invariably cause injury to the meat.

STEAM COOKING

Following butchering and washing, the fish are, as has been indicated, placed in wire trays which fit into mobile racks. A rack of



FIG. 90. Running a rack into the steam cooker.

standard size holds two tiers of trays, seven trays to the tier. The standard cooking chambers hold as a rule 5 or 8 racks and are either about 13 or about 20 feet in length. They are constructed of heavy sheet iron and, as no pressure is required, are not airtight. (See Fig. 90.)

Temperature of the pre-cook varies with the cannery from 214 to 220 degrees F. The cooked fish may be soggy if cooked at 212 degrees or less; a temperature of over 220 degrees can be obtained but is not workable. Experiments have been made using a temperature of as much as 240 degrees F., but while time was saved the condition of the meat was not satisfactory as hurrying the cook resulted in discolored meat from insufficient drainage. Particularly stearin between the layers did not have time to soften

and drain and, as one operator remarked, "showed up like cheese after the cook." As well, the high temperature cooked out the desirable natural juices. Time of the cook varies primarily with the size of the fish. It is affected as well by the ideas of the individual cannerymen and the species and condition of the fish. The object is to give a thorough cook, continuing until the flesh is easily separated from the

bone and the skin comes off with ease. Such oil as is present and a good deal of the moisture are cooked out at this time.

Cooking temperature must be attained gradually or injury to the tissues will result. In general, fish brought in fresh require less time to reach cooking temperature, whereas small fish are brought up more rapidly than are the large. Estimates of time required vary from as little as 15 minutes for small skipjack to an hour for large yellowfin. One plant will take 30 minutes to reach cooking temperature with a small fish; another will reach that level in 40 minutes with a large "hard" fish; another may not differentiate as to size and allow 45 minutes for any fish. This variation between the plants may be explained, in part at least, by the differences in thawing times and methods; *e.g.*, one concern will start the cook when the fish are much colder than will another.

Time of the actual cook varies from two to eight hours. Small skipjack can be cooked in 2 to 2½ hours. They may however be held as long as 3. Up to 25 pounds, the cook may run 3 to 4 hours. Medium sized fish cook 4 to 6 hours; an 80-pounder will require 6, whereas fish of 100 pounds and up require a full 8 hours. Fresh-caught fish may require a slightly longer cook than do those brought in frozen.

At the conclusion of the cook, the racks are wheeled from the cooker and allowed to cool. Usually, cooling goes unassisted regardless of weather although occasionally, a system of blowers is used to circulate air in hot weather. Air temperature is of course the regulating factor in cooling. Fish may stand as long as three days during the winter in the San Pedro area without spoiling. During the summer, the limit is about 24 hours. In general 8 to 24 hours is sufficient for cooling. Twenty-four hours is about the maximum standing time allowed in San Diego, with 12 to 18 hours the more customary period. Some plants give the fish a short steam cook of ten minutes or so before cleaning if the fish have stood long enough to dry excessively.

In general, the length and temperature of the steam cook are not checked by automatic recording thermometers as must be done in retorting. The usual method is to chalk the starting time together with the anticipated stopping time on the door of the cooker while temperature during the cook is read off an ordinary thermometer. One concern does, however, utilize the more refined method of recording thermometers and timing devices.

CLEANING

The cooked and cooled fish are prepared for packing by women workers. All nationalities are represented at the cleaning tables of the various plants; in general, the older women are found there while the younger ones do the packing.

The cooking racks are wheeled to the cleaning tables where men remove the trays, dumping the fish for the cleaners as required. The tables may be located in a separate room or they may be found immediately adjacent to the packing lines.

Cleaning methods are similar in all the plants. The heads are broken free, the skin is scraped off and the body broken in half longitudinally. This exposes the backbone which is lifted out. The halves are split longitudinally and the dark meat (located in a layer



FIG. 91. Cleaning the fish. The prepared strips are placed on the boards seen at the right, flakes go into the pan, waste material into the barrel.

around and below the spinal column) is carefully scraped away. Dark meat, bones, skin, fins and head are all dumped into containers for removal to the reduction plants. The long, slender strips of white meat, which correspond to the dorsal and ventral musculature, are placed on wooden trays which when filled are removed by the men workers. (See Fig. 91.) These trays are racked in wheeled carriers for transport to the slicing machines. Smaller bits of white meat are kept separate for use in the "salad" or "flake" pack or for filler in the "standard" pack. Inspection of cleaned fish varies in intensity from little if any to a careful examination of each tray before it reaches the slicer. In some plants, each cleaner is given a number and she must place a tag bearing that number on each tray of meat which she has cleaned. Each tray is then examined as suggested above with the additional check on each worker.

Slicing machines resemble miniature guillotines. The trays bearing the strips of meat are placed on a conveyor which moves under a knife blade so regulated as to cut the strips at the desired width for packing. The cut is always across the muscle fibers, *i.e.*, across the long strips of meat. (See Fig. 92.)

PACKING

In general, three grades of pack are put up, commonly termed "solid," "standard," and "salad" or "flake." The solid pack consists only of large chunks of the finest meat. No small bits of meat are used in this pack. The standard pack is made up primarily of large

pieces but a certain proportion of flakes is used; the amount allowed varies with the plant and may be as little as 10 or as much as 33 per cent; it is usually held to about 15 per cent. The standard pack is calculated to absorb all of the flake material of a given run. In the salad pack, all small bits of meat are used; the bulk of this pack results when no standard pack is being put up. If the meat is tender and brittle, more flakes will result than will from dry. Usually, the type of pack to be used for a given lot is determined before the packers start work. Occasionally, a lot of mixed quality is packed more or less standard; a forelady then sorts the tins as they are en route to the capper, removing any which seem worthy of labeling under the finest brand. One plant uses this method quite regularly when the pack is nominally standard, the workers using a solid pack whenever it is possible. The bulk of the tuna pack—about 80 per cent—is placed in the familiar round half-pound tins. Quarter-pound and full-pound cans make up most of the remaining 20 per cent, though a few plants are equipped to handle four-pound tins. These last are, as may be expected, designed for hotel, restaurant and institutional trade. The half-pound tin is used almost exclusively for the flake pack; the quarter-pound almost never. A detailed analysis of the pack is found in Table 2.

Unlacquered tins are the rule. Recently, however, some plants have taken to placing part or all of their output in cans which are lacquered on the inside. By this, discoloration of the tin caused by extended contact with the meat is eliminated, the result being a pack



FIG. 92. Slicing the meat. The racks in the background hold meat already sliced, the method employed in this plant being to run the racks between the packing lines where they are unloaded as needed by the workers. Note the State inspector at the right.

of finer appearance. It is felt that use of the lacquered cans will become the rule rather than the exception. One San Diego concern uses specially made aluminum cans for its fancy pack. Some difficulty was experienced at first with these containers, but it is claimed that most of the troubles have been eliminated and that the pack is considered very fine.

TABLE 2
Tuna and Yellowtail Pack, 1936-1937¹

Size of cans ²	Number of cases					
	1936			1937		
	San Pedro	San Diego	Total	San Pedro	San Diego	Total
Albacore—						
4-lb., 12's	838		838			
1-lb.	8,585		8,585	11,642	102	11,744
1/2-lb.	43,525	35	43,560	71,268	7,934	79,202
1/4-lb.	901		901	147		147
1/4-lb., 100's				66		66
Bonito—						
1-lb.	7,749	6,580	14,329	16,856	6,757	23,613
1/2-lb.	55,747	29,657	85,404	64,970	35,551	100,520
1/4-lb.	1,464	506	1,970		1,430	1,430
1/4-lb., 100's	3,375		3,375	3,683	316	3,999
Bluefin						
1-lb.	13,843	1,506	15,349	16,542	1,611	18,153
1/2-lb.	247,752	18,235	265,987	140,492	20,853	161,345
1/4-lb.	24,546	2,649	27,195	19,926	3,091	23,017
1/4-lb., 100's	24,638		24,638	10,843	1,548	12,391
12 oz.	1,208		1,208	629		629
Yellowfin—						
4-lb., 12's	811	841	1,652	962	450	1,412
1-lb.	33,243	68,294	101,537	42,787	89,866	132,653
1/2-lb.	279,409	864,796	1,144,205	333,422	916,287	1,249,709
1/4-lb.	24,626	123,192	147,818	29,995	157,169	187,164
1/4-lb., 100's	4,284	17,688	21,972	8,155	2,094	10,249
12 oz.	861		861	1,290		1,290
Striped (Skipjack) —						
1-lb.	7,016	12,802	19,818	13,748	17,414	31,162
1/2-lb.	138,739	235,577	374,316	198,964	408,960	607,924
1/4-lb.	9,044	24,125	33,169	14,316	24,636	38,952
1/4-lb., 100's	29,557	22,826	52,383	49,137	36,741	85,878
12 oz.	574		574			
Flakes—						
1-lb.	814	2,300	3,114	8,716	2,563	11,279
1/2-lb.	9,092	12,431	21,523	25,818	12,947	38,765
1/4-lb.		236	236		394	394
Tonno—						
1/2-lb.	6,450		6,450	11,404		11,404
1/4-lb., 100's	51,347	740	52,087	125,208	1,125	126,333
Yellowtail—						
1-lb.	6,157	12,471	18,628	1,545	14,968	16,513
1/2-lb.	10,912	82,208	93,120	1,807	29,131	30,938
1/4-lb.		380	380		29	29

¹ Forty-eight cans to the case unless otherwise specified.

² From "Statistical Reports on Fresh and Canned Fishery Products, Years 1936-1937," by S. H. Dado. California Division Fish and Game, Circular, Nos. 11, 12.

Albacore is considered the finest meat and commands a premium price. It alone can be marketed as "white meat tuna." Color is the prime consideration of the American buyer; whether or not this distinction is reflected in the taste of the fish is a matter of question. Of the species more commonly taken, yellowfin provides the fanciest pack. Varying with time of year, locality taken, food, and other similar fac-

tors, the meat is of light color and good appearance. It is the finest of the yellowfin pack (fish of 30 to 60 pounds are preferred) that is marketed under the best known trade names. The designation "light meat tuna" is permissible on yellowfin, bluefin and skipjack. As a rule, bluefin and skipjack are packed standard.

Details of packing vary considerably from plant to plant. In all, conveyors (either belt or chain), which carry empty tins to the packers and the filled tins back to the capping machines, run the length of the long table at its center. Workers, all women, line the tables on both sides. In some plants, a series of rollers runs along the top center of the table down which the trays of sliced meat are shoved. Men lift the trays down beside the packers as they are required. Other plants rerack the trays after the meat is sliced; the racks are then wheeled between the packing tables and the trays removed as needed. (See Fig. 93.)



FIG. 93. General view of the packing lines. The slicing machine seen in figure 92 is to the right of the table in the foreground. Closing machines are in the left background.

All the tins are packed by hand, and the speed and accuracy with which they are filled is amazing. The slices of meat, as has been indicated, are cut to the proper height for the size tin in use. This results in the half-pound can being filled to within about a quarter of an inch of the top. Actually, a $\frac{3}{16}$ -inch headspace is calculated upon. Of this, the affixed lid will fill $\frac{5}{32}$ -inch. The chunks of meat are carefully fitted into the tin so that no space is left in the solid pack and just enough in the standard to hold the desired amount of flakes. A quick tamping of the filled tin with the heel of the hand and it is stacked before the worker. (See Fig. 94.) Balance scales are found beside each worker but are little used. An experienced packer feels confident of her ability to place the proper weight of meat in each can. A forelady periodically examines the filled tins of each worker, checking her



FIG. 94. Packing the tins. When filled, they are placed on the shelf seen in the upper right corner where they remain until checked by the forelady.



FIG. 95. Salt and oil dispensers. The tins pass from right to left. In this plant, a steady stream of oil falls from numerous holes in the pipe marked "1."

card with the number filled. The tins are then placed on the conveyor which carries them to the capping machines. The four-pound cans are packed in a slightly different fashion. Two layers, each cut to the width used in the one-pound tins, are used. This is a solid pack entirely. Minimum allowed weights of meat for the various sized containers are given in table 3.

TABLE 3
Minimum Retorting Times and Net Weights of Meat for the Various Tins^a

Tin	Retorting time at		Minimum net weight of meat (ounces)
	240° F.	250° F.	
1/4-lb.-----	65 min.	40 min.	3.50
1/2-lb.-----	75 min.	55 min.	5.75
1-lb.-----	95 min.	80 min.	11.50
4-lb.-----	230 min.	190 min.	46.00 ^b

^a Figures given by the California State Department of Public Health.

^b Approximate.

Salt and oil are added to each tin by special dispensers. (See Fig. 95.) Most commonly, both are added (the salt first) just before capping. Occasionally, either or both are placed in the tins before packing. Oil is rarely added first, because of the resulting messiness along the packing line, though some operators feel a more satisfactory permeation of oil, together with a lessening of the danger of scorching one surface during retorting, would result if some of the oil were added before and some after packing. This method is employed in the four-pound pack, where one plant at least places some oil in the empty tin, some between the layers, and the balance on the top. Another method applied to the four-pound pack is to pass the filled tins under two sets of spigots four or five feet apart. The cans are filled to overflowing under the first set; by the time the second set is reached the oil has been fairly well absorbed and the tin is again filled. Some plants which use exhaust boxes add about one-third of the oil before exhausting and the balance after. If the exhaust method is employed it is customary to heat the oil. The temperature level maintained varies with the plants; in some the oil is merely warmed, in others it is kept as hot as 180 degrees F., at which level it is held constantly by one concern. Most of the companies do not attempt to regulate the temperature that closely. Another concern adds part of the oil cold before exhausting and the balance warmed after exhausting. Heating the oil results in a somewhat higher vacuum than would otherwise be obtained in the exhaust. A more satisfactory permeation through the meat is claimed as well. However, one concern which uses neither exhaust nor vacuum claims that the use of warm oil in the larger tins is not satisfactory, as it tends to disrupt too much fine material which in turn leads to a product of inferior appearance. This company does warm the oil for the quarter-pound pack for reasons discussed later. Hot oil can not be used successfully in a vacuum pack.

Estimates as to the exact amount of salt and oil to the tin were difficult to obtain. One company, however, has measured carefully the amount of each with these results:

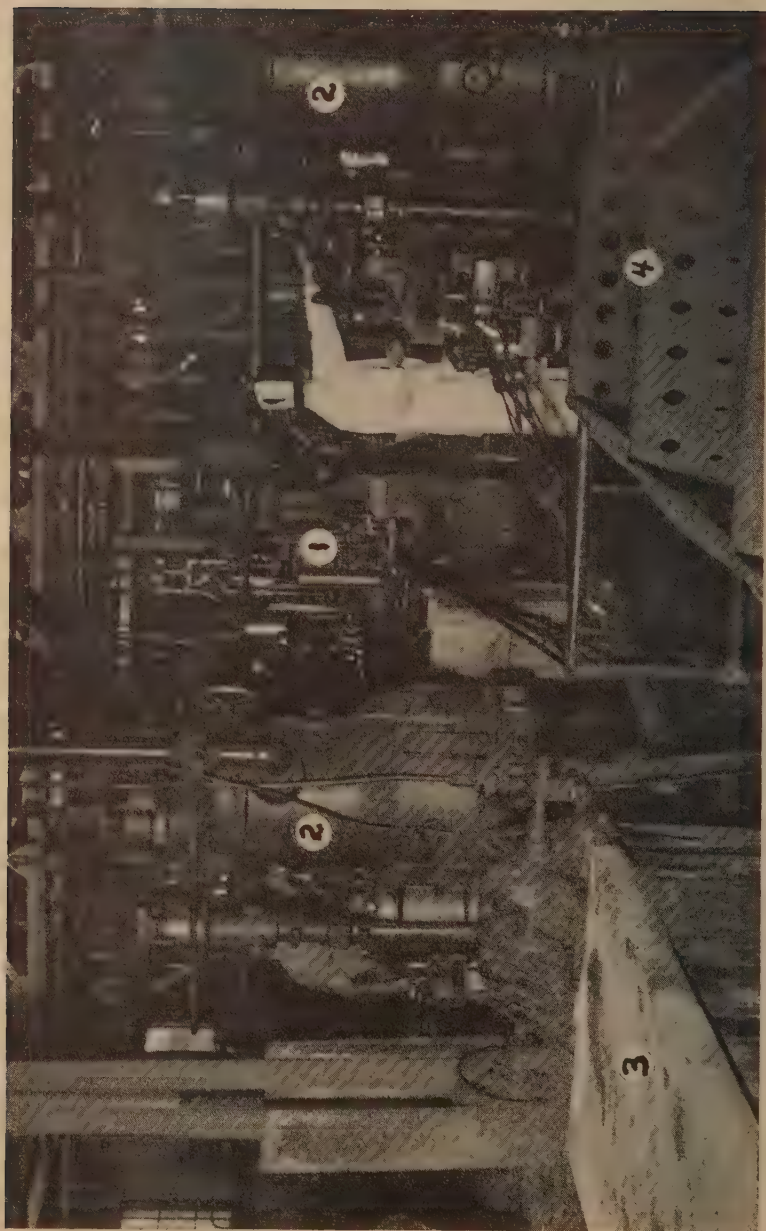


FIG. 96. General view of vacuum closing machinery. The girl operator is placing lids in the capping machine. A stack of lids may be seen directly to the left of figure "1" which indicates a capping machine. The vacuum machines are marked "2". Tins may be seen emerging from the machine on the right. They are washed in the vat marked "3." Retort baskets marked "4," are seen in the lower right corner.

one-quarter-pound:	2.83 grams salt, $\frac{1}{2}$ ounce oil
one-half-pound:	3.54 grams salt, $1\frac{1}{2}$ ounces oil
one-pound:	4.25 grams salt, 2 ounces oil

Other plants generally estimate the salt added as about half a teaspoon to the half-pound tin, with correspondingly less for the quarter-pound and more for the one-pound. About 24 grams is placed in the four-pound can. In general, the salt dispensers do not work too efficiently, and often one tin may receive less than its share whereas the next receives more. Estimates of the amount of oil added showed a good deal of difference between plants. One company calculates four pints to the 48-tin case, half-pound size; and six or seven pints to the one-pound case. Another adds six pints to the half-pound case and a full gallon to the one-pound case. The four-pound tins require some nine ounces. In any event, enough must be added to meet the minimum weight requirements for the various tins. A bland vegetable oil is used exclusively.

A constant flow of oil is maintained through a number of small spigots. (See Fig. 95.) There are enough of these so that each tin is completely filled by the time it has passed under all (unless but a portion of the oil is first added, in which case the number of spigots is correspondingly low). The conveyor tips slightly after oil is added to remove the excess. In some cases this is done immediately after the oil is added; in others it is somewhat delayed to permit a little permeation. A collecting basin is located below the oil dispensers. There the oil which did not fall into the cans (the oil flow is constant while the tins do not come by in a steady stream) is collected and piped off to be filtered and used again.

Vacuum closing machines are now used commonly. The tins follow the conveyor which has carried them from the packing table and pass under the salt and oil dispensers (unless, as noted above, the salt or oil is added prior to packing). Usually they first pass under a machine which tamps down the surface of the contents of each tin. The vacuum method of sealing labored under difficulties before this device was introduced. The reason for this was the tendency of the packers, who were paid by the number of tins they filled, to leave a vacant space in the bottom of the can. The air trapped therein could not be completely pulled by the vacuum. Generally, a watch is kept and tins notably over- or under-filled removed. From the tamper the conveyor leads directly to a machine which crimps on but does not seal the lid. From it the tins pass directly to the vacuum machine, a device which sucks out the air by means of a pump, the while sealing the lid. A vacuum of 10 to 12 inches is obtained in the tin; vacuum in the chamber may equal 20 inches, though it is more often about 15 inches. The large modern machine will handle 130 cans per minute. Often one or two auxiliary machines with capacities of up to 60 tins per minute are placed in the line, thus greatly increasing the amount which can be handled. From the closing machine, the tins pass through a bath of strong soap in boiling water, after which they are rinsed in boiling water. (See Fig. 96.) The conveyor terminates shortly thereafter, the tins falling into the large iron baskets in which they will be retorted. The purpose of the bath is to remove any adhering oil or other foreign

material. While as strong a soap as possible must be used, care must be taken that it is not so strong as to injure the seams of the cans.

The exhaust box is still used in several plants. It consists of a long, enclosed steam chamber open at both ends, and heated with live steam at no pressure to a temperature of about 210 degrees F. Through it the conveyor passes. (See Fig. 97.) Each tin is exhausted for 1½ to 7 or 8 minutes. Salt and oil may be added before or immediately following the exhaust. Frequently part of the oil is added before and part after. Generally, the oil is heated, resulting in a higher vacuum. The tins usually pass directly to the capper, though they may go through a short "hot box" en route. The cans are washed as described above.

In the exhaust, air is driven out of the spaces in the tin and these spaces are in turn filled with live steam. The tin does not cool suf-

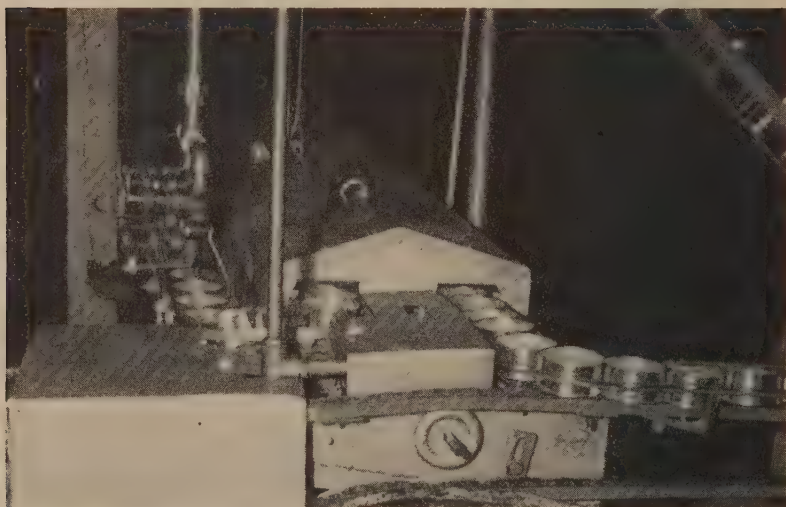


FIG. 97. An exhaust box. The tins enter at the right and emerge at the left, passing there under the oil dispenser seen at the side of the box. Salt has been added previously. The line of tins seen in the upper right corner are empties en route from warehouse to packing line.

ficiently to allow condensation until after the lid is sealed, the net result being the formation of a vacuum. A four-inch vacuum is unusual; more often it is two- or three-inch. As with the vacuum pack, from 130 tins up per minute pass through the cappers. It should be noted that these speeds do not apply to the four-pound pack as the lines handle but 20 or so of this size per minute.

Proponents of the vacuum pack argue that the higher vacuum obtained is desirable and that the additional cook given by the exhaust box is unwarranted in the case of tuna; hence there is no reason for incurring the expense of running one. Furthermore they claim that even with the best of care the box can not be kept in a completely sani-

tary condition. Operators using the exhaust method claim that the relatively low vacuum is ample, that they do not feel it more expensive, and that sanitary conditions may be maintained. Their chief claim is that a more uniform pack results; that the oil is sweated completely through the pack, thus eliminating any danger of scorching at one end while the tins are being retorted.

As has been mentioned previously, two plants use neither exhaust box nor vacuum machine on the bulk of their pack. They claim no difficulty with this "cold pack" at the relatively low altitudes at which their product is distributed and consequently see no reason for installing the expensive machinery which would be required to obtain a vacuum. The exception lies in the quarter-pound pack; tins of this size seem to require at least a minimum vacuum. One of the plants uses the standard vacuum machine on this pack, whereas the other simply adds warm oil, thereby obtaining something of a vacuum when the tins cool.

RETORTING

After washing, the sealed tins are dropped from the conveyor into the large iron baskets which, when filled, are wheeled into the retorts. Cooking time and temperature are governed by State law; automatic recording thermometers must be attached to each retort and the resulting charts showing temperature in the retort and time elapsed must be turned over to State officials. Most packers retort at a minimum of 240 degrees F., though to be on the safe side the temperature is often held at about 242 degrees F., while not infrequently the process is continued a few minutes more than is required by law. Pressure under these conditions is about 11 pounds per square inch. A few operators prefer a shorter retorting at 250 degrees F. Minimum requirements at these temperatures are given in table 3. A longer retorting at 230 degrees F. is permitted but no packers operate at this temperature. At the conclusion of the cook, steam is shut down and a stream of water turned into the retort while air pressure is increased to about 15 pounds. Pressure is gradually released as temperature decreases and at the end of 10 to 20 minutes the retorts can be opened. Temperature is not over 170 degrees at this time, and it may be reduced to 100 degrees before opening. Increasing the air pressure is essential; if this were not done, the drop in pressure occasioned by the condensation of the steam would cause the retort to collapse. The tins themselves might buckle if subjected to a sudden decrease in external pressure. Cooling can be accomplished by lowering the temperature slowly, but as the process is time-consuming it is used only in emergency.

Further cooling takes place in the open air, after which the tins are labelled and cased. The bulk of the pack goes 48 cans to the case; quarters are most frequently packed 100 to the case, whereas the 4-pound tins are packed 12 to the case. (See Table 2.)

Upon request of a packer and with the approval of the State Department of Public Health, the following legend may be printed on the label: "Packed and sterilized under the supervision of and according to the regulations of the State of California, Department of Public Health."

INSPECTION

The fish are subjected to rigid inspection by officials of the State Department of Public Health from the time of arrival at the cannery. Any fish in which the gills show signs of spoilage or in which the flesh is bruised or torn are immediately rejected and their weight deducted from the total landing of the boat. If a lot is of doubtful quality, the fish are packed but held apart from the balance of the output. Ultimate rejection or acceptance of the lot in question is determined by tests made upon a sample withdrawn from the lot. A further check is maintained at the cleaning tables and at the slicing machines. (See Fig. 92.) Any meat rejected after cleaning is weighed, the amount multiplied by a factor accepted by both canner and fisherman (usually 3:1 in the case of fully cleaned meat and 2:1 if head, skin and bones are included), and the poundage deducted from the earning of the boat. Rejection is based primarily on smell; the inspectors become so experienced that this method is quite effective. Texture is a factor as is appearance; "honeycombed" meat is rejected.

As mentioned previously, retorting is controlled by State law and it is here that the most stringent control is exercised. Minimum time and temperature are set by law, these minimums being set so high that infection from the canned product is impossible even though spoiled meat may have by some chance reached a tin and passed inspection. (See Table 3.) The automatically recorded charts showing duration and temperature of each retorting together with the production reports of the plants are turned over to the department and checked. In addition extensive samples are drawn from each lot of canned fish and these are carefully examined in the laboratories maintained by the department. Not until approval is given by the State officials can a given lot be released for distribution. The effectiveness of this stringent checking is evidenced by the fact that not a single case of botulism resulting from a person's eating a product commercially canned in California has been reported since 1925.

REDUCTION

Viscera, heads, bones, dark meat and any damaged or spoiled fish go to the reduction plant to be dried and ground for use as fish meal feed or fertilizer. The previously uncooked viscera are given a steam cook before reduction to avoid clogging the machinery. Generally, the reduction plant is part of the cannery but a few of the San Diego plants send part or all of this material to a company specializing in the reduction of various substances. Tuna meal is considered to be of fine texture and high quality.

Oil content is very low in the tuna. Reports vary from none recoverable to $7\frac{1}{2}$ gallons or even a little more per ton.

"TONNO" AND OTHER SPECIAL PACKS

Solid pack tuna, in which olive oil is substituted for cottonseed, is marketed extensively in regions with a large Italian population under the name "tonno". The bulk of the pack is in quarter-pound tins; a small amount is packed in half-pound tins, and at least one plant is now using some four-pound containers. Almost the entire pack is put up by a few of the plants in the San Pedro area.

Packing methods are similar to those used for solid pack tuna. A double portion of salt is added and a slightly greater amount of oil may be used; one plant uses seven-eighths of a gallon of olive oil per case (100 quarter-pound tins or 48 half-pound tins) of tonno as against three-quarters of a gallon of cottonseed per case of tuna. This is accomplished by leaving a slightly greater headspace in the tin than is allowed for the tuna-style pack. The cover of the tonno can is lacquered and the word "tonno" labelled thereon. A special wide-lipped lid removable by hand is used.

In general, darker and stronger meat may be used in tonno than in fancy tuna, as the Italian buyer is not as critical in this matter as is the average American. Yellowfin, bluefin and skipjack are canned as "tonno," with skipjack the preferred species.

One concern markets a special tonno pack in half-pound tins, in which a layer of string beans is placed below and above the meat. This same company also packs a specialty known as "Ventresca." The bellies of large (40 to 50 pounds and up) fat bluefin are cut into pieces to fit half-pound cans. The skin is not removed. The pieces are boiled in a saline solution and packed, one piece to the tin, with a great deal of olive oil. It is reported that the boiling has lately been eliminated, the fish now being packed raw. This product commands a high price in Italian communities.

Another interesting pack is marketed by one concern—canned creamed tuna. For this pack, meat of the finest quality and appearance—primarily yellowfin—is used. The cooked meat is diced and packed with a liberal portion of sauce containing just the ingredients which would be used at home. It is placed in a tall 12-ounce tin and retorted for 75 minutes.

YELLOWTAIL

Relatively small amounts of yellowtail are canned. No yellowtail taken in American waters can be packed, so that which is processed comes perforce from below the international boundary. San Diego plants handle most of the catch.

Packing methods are similar to those used for the standard tuna pack, with the steam cook lasting from $1\frac{1}{2}$ to 3 hours. Half-pound tins are used primarily, though a one-pound pack is prepared as well. The product is marketed as "white meat fish" and with the word "yellowtail" frequently added as well.

BONITO

Bonito, though a tuna, can not be marketed as such as the meat is not up to the quality of the other species. It is packed just as are the others. It is labeled as "white meat fish," as is yellowtail. The word "bonito" is usually added as well.

MACKEREL

Although the bulk of the mackerel canned in California is packed salmon style, some is packed tuna style at San Diego in half-pound and one-pound tins. One plant is now attempting to build a general market for this pack; this plant uses only large fish and pays a premium

price to the operators of several small set line boats. Another concern packs small deliveries in this fashion in preference to using its regular mackerel line for a short run. This company makes no attempt to advertise and sells the pack locally. Mackerel packed in this way is admittedly very good; it is the difficulty in preparing such small fish that keeps some of the other operators from attempting this pack. Packing methods are similar to those used for tuna. The steam cook lasts for about 20 minutes; the fish are in the cooker for perhaps an hour.

NOTES ON GROWTH OF GOLDEN TROUT (*SALMO AQUA-BONITA*) IN TWO HIGH SIERRA LAKES ¹

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Many fish culturists and anglers have noticed that planting fishless lakes with trout often results in very rapid growth during the first few years. That this is due to abundant food supplies for the first planting of fish, is generally recognized. Succeeding generations of naturally propagated or planted fish do not find food in such unused abundance; as a result, competition for food becomes keener and lowers growth rates. Rates of survival in the young are probably likewise reduced by the larger fish turning to cannibalism as food supplies become reduced. Certainly fewer young fish will be eaten by older ones where a homogeneous population of fish of the same age is present. Observations by many workers have shown that lakes containing fish are much poorer in available foods than unstocked lakes.

Few records are available, giving actual measurements of growth of trout in High Sierra Lakes, to show exactly what growth was achieved in any given interval of time, or in any given type of lake. Such observations have usually been based on random observations or hearsay. It is the purpose of these notes to present more concrete data on the growth rates of golden trout following planting in two barren lakes, Bright Dot and Bighorn, lying high on the east slope of the Sierra Nevada Mountains, about thirty-eight miles north of Bishop, California.

Bright Dot Lake is a beautiful High Sierra lake of nearly 100 acres, located on the south shoulder of Mt. Morrison, in the Inyo National Forest, at an elevation of approximately 11,000 feet. It lies in a rocky basin with small meadows at its upper and lower ends. No inlet is present. An outlet flows over coarse, flat rocks some hundred yards into a small, shallow pond about three feet deep. Just below this the water plunges precipitously into Convict Creek Canyon and courses about three miles into Convict Lake. Previously, Bright Dot Lake was barren of fish and, due to its inaccessibility, had been seen by few people. Inspection prior to planting showed an abundant food supply. Seuds or "shrimp" (*Gammarus limnaeus*), water boatmen, midges, diving beetles, and other aquatic foods were numerous.

¹ Published by permission of the U. S. Bureau of Fisheries and the California Division of Fish and Game. Submitted for publication, February, 1938.



FIG. 98. Bright Dot Lake, Mono County, California. This attractive, glacial lake lies at an elevation of approximately 11,000 feet, in a rocky basin with small meadows at its upper and lower ends. September 10, 1937.

No suitable spawning areas were found. The outlet was dry when the lake was visited in 1937, two years after it was planted, and a few fish were seen stranded in the pond below the lake. Evidently, during periods of high water, a few fish had descended the outlet before it dried up.

On September 28, 1935, 9797 golden trout, averaging approximately 1.2 inches in length, were packed on horseback from the end of the road at the Convict Lake Resort and planted in Bright Dot Lake. The eggs from which these fish were reared had been taken at the Cottonwood Lakes and transported to the Hot Creek Hatchery where the young from them were grown to planting size. The data submitted for these trout indicates the growth rate from the time of planting to approximately two years later, when two separate samples were obtained on different dates, as noted below.

Bighorn Lake lies at an elevation of about 10,700 feet, at the head of Convict Creek Drainage, just below the main north-south Sierra escarpment. It drains into Lake Dorothy, which is the largest High Sierra lake in the Convict Creek drainage. Its basin is rockier than that of Bright Dot and it lacks any meadow-like areas along its margin. Examination of Bighorn Lake prior to planting also showed an abundance of available food, but apparently the lake was not as rich as Bright Dot. While no scuds were collected prior to planting, stomach examinations subsequently revealed this food. Scuds have likewise been found in the stomachs of trout caught in Lake Dorothy. The latter lake lies at an elevation of 10,340 feet.

Bighorn Lake was planted September 11, 1936. Approximately 8000 trout averaging 1.2 inches in length were packed on horseback to the lake.

The data submitted below are based upon a total of 47 specimens, of which 28 were preserved, 16 from Bright Dot Lake and 12 from Bighorn. All samples were taken with rod and line.

Acknowledgment is here made to Mr. R. C. Lewis and Mr. Leo Erkill, who assisted in rearing and planting the fish; and to Mr. William Garner, Mr. H. John Rayner, Mr. Roy Boothe, and Mr. Fred Johnson, all of whom assisted in collecting the fish.

RATE OF GROWTH

While growth of trout in High Sierra lakes is said to be generally slow by reason of short growing seasons, poor food, and cold water, the data submitted in table 1, for golden trout planted in Bright Dot and Bighorn lakes, shows in these fish surprising growth. For instance, the fish planted in Bright Dot Lake increased about 7 times in length in about 23.4 months after planting. In slightly more than a year, fish planted in Bighorn Lake increased over 4 times in length. In Bright Dot Lake the fish ranged from approximately $5\frac{1}{2}$ inches to over $10\frac{1}{2}$ inches. Fish up to a half pound were taken in Bright Dot though the average weight attained was about one-quarter pound. The Bighorn fish averaged about 5 inches long and weighed about one ounce.

As shown in table 1, fish caught in Bright Dot Lake on September 10, 1937, averaged 8.3 inches in length. This growth was achieved after two and a fraction growing seasons in the lake. Fish caught in



FIG. 99. Bighorn Lake, Mono County, California. This lake lies at the head of the Convict Creek drainage, at an elevation of 10,700 feet. The summit of the main north-south Sierra escarpment is seen in the upper background. September 29, 1937.

Bighorn Lake on September 29, 1937, averaged 5.01 inches after one and a fraction growing seasons in the lake. The rapid rate of growth and generally excellent condition of these fish are doubtless due to great abundance of food in such unstocked lakes.

TABLE 1
Growth of Golden Trout in Bright Dot and Bighorn Lakes, Mono County, California

	Bright Dot Lake		Bighorn Lake
	Planted Sept. 28, 1935		Planted Sept. 11, 1936
Average size at planting, in inches.....	1.2		1.2
When taken.....	Aug. 17, 1937	Sept. 10, 1937	Sept. 29, 1937
Number caught.....	4	31	12
Average length when caught, in inches ^a	8.28	8.30	5.01
Range in length, in inches ^a	6.9-9.8	5.3-10.6	4.3-5.4
Average weight, in ounces.....	4.03	4.03 ^b	.903
Range in weight, in ounces.....	2.5-6.1	1.04-8.2 ^b	.58-1.14
Time in lake, in months.....	22.7	23.4	12.6
Total growth since planting, in inches.....	7.08	7.1	3.81
Average condition factor based on standard length.....	1.500	1.514 ^b	1.055

^a Total lengths given: from tip of snout to center of fork in tail.

^b Average weights and condition factors determined from 12 preserved specimens out of the 31 caught on date listed in this column.

If the average increment in length of fish in each lake be divided by the time interval after planting, it will be seen that the average growth rate for all trout was about three-tenths of an inch per month. This figure is based on a growing season of 12 months. However, if the months of January to April, inclusive, are grouped as a period of relatively little growth, the rate of growth over the other eight months will be seen to average slightly less than half an inch per month. Lack of data from these and other High Sierra lakes does not permit exact calculations of growth rates in relation to seasons of growth; hence, these figures are only approximate.

With golden trout of two known ages at hand, it was thought desirable to examine scales for winter checks at each age level. In scales of the year-old trout from Bighorn Lake no winter check could be found, despite the fact that these fish were taken in the second growing season after one winter in the lake. In scales from fish slightly less than two years old from Bright Dot Lake, only a single winter check was found, although these fish were taken during their third growing season after two winters in the lake. These facts lead one to believe that, in all probability, scales were not formed until the fish were in their second summer, a possibility pointed out by Curtis (1934), with reference especially to scale formation in hatchery-reared fry after planting.

The evidence shows that under the favorable conditions offered by the two unstocked lakes the golden trout, following planting, developed at a very satisfactory rate. In specimens from both lakes the flesh was firm and pink, especially in the largest individuals. An abundance of rich, pink fat was found along the stomach and intestines. William Garner, of Convict Lake Resort, remarked that, figuratively, one could "cut steaks from their bellies."

The color of the larger, freshly captured fish from Bright Dot Lake was very brilliant and typical of golden trout. Spotting, in most

specimens, was slight and was restricted for the most part to the caudal peduncle. A few specimens showed a few scattered spots along the upper side of the body, both in front of, and behind the dorsal fin.

LENGTH-WEIGHT RELATIONSHIP

In the present study total and standard lengths were taken from the 28 preserved trout from both lakes. Weights (in grams) were taken of the same series of trout following removal of excess moisture from the surface with absorbent paper for about $1\frac{1}{2}$ minutes. From the measurements obtained, condition factors² were calculated in grams-centimeters for each individual. Averages and extremes in condition factors for 16 golden trout from Bright Dot Lake were, 1.500 (.990-1.991); and those for 12 specimens from Bighorn Lake were, 1.055 (.839-1.650). The average factor for all 28 trout was 1.315.

Curtis (1934), in his study on trout of the same stock from Cottonwood Lakes, which were first planted in 1891, calculated from total lengths an average condition factor of 1.07. The average condition factor based on total lengths of trout included in the present notes was 1.196.

STOMACH CONTENTS

Some information on foods in the lakes was gained by a study of stomach contents. In the accompanying table 2, foods are divided into two classes: general and plankton-crustacea. The former includes insects and scuds, while the latter covers only the minute, free-swimming or drifting forms common in open waters of lakes, such as water fleas, copepods and others.

Among general foods eaten by the fish from Bright Dot Lake, caddis-fly larvae (Trichoptera) formed 43.91 per cent, and midges (Chironomidae), 42.48 per cent; these two groups totaling over 85 per cent, by number, of all general foods eaten. In fish from Bighorn Lake, caddis-fly larvae formed 64.85 per cent, while midges made up 31.18 per cent. The two groups totaled over 96 per cent of all general foods eaten. The importance of caddis-fly larvae and midges as food of trout in California has been stated in recent studies by Needham (1934) and Rayner (1937). Certainly, in the two High Sierra lakes concerned in this study, both organisms were about of equal importance.

Of the plankton-crustacea eaten, water fleas and copepods comprised over 99 per cent of this class of food in the fish from Bright Dot Lake, and copepods predominated in the Bighorn specimens.

On September 10, 1937, golden trout were observed "nosing" into the marginal bottom of Bright Dot Lake. The trout were evidently feeding directly on the bottom. This was indicated by the numerous caddis-fly and midge larvae found in the stomachs. This activity could only be seen when the wind was not rippling the surface of the water.

² Condition factor is a measure of the plumpness of fish in relation to length. The formula used is:

$$\text{a (condition factor)} = \frac{100 \times \text{weight in grams}}{(\text{Standard length in centimeters})^3}$$

TABLE 2

Foods Eaten by 16 Golden Trout from Bright Dot Lake, and 12 from Bighorn Lake, Mono County, California^a

Foodseaten—general	Bright Dot Lake		Bighorn Lake	
	Number of items	Per cent	Number of items	Per cent
Beetles	34	4.40		
True bugs	19	2.46	1	0.49
Caddis-fly larvae	339	43.91	131	64.85
Midges	328	42.48	63	31.18
Bees, ants, wasps	34	4.40		
Leaf-hoppers	13	1.68		
Scuds (<i>Gammarus limnaeus</i>)			6	2.97
Miscellaneous	5	0.64	1	0.49
Totals	772		202	
Plankton-Crustacea				
Water fleas (<i>Cladocera</i>)	250	19.2		
Copepods (<i>Diaptomus</i>)	1,050+	80.7	4,303+	99.86
Miscellaneous	4		1	
Totals	1,304		4,297	

^a Average and extreme measurements of trout in inches were: Bright Dot Lake, 8.29 (5.3-10.6); Bighorn Lake, 5.00 (4.3-5.4).

Scuds or "shrimp" were found in only two fish from Bighorn Lake. These organisms were collected from Bright Dot Lake prior to stocking in 1935, but were not found in the trout. Observations showed that the planted fish had greatly reduced the quantity of this food.

Nearly 7 per cent of the general foods found in Bright Dot fish consisted of beetles and true bugs. Among the beetles a number of larvae of the dytiscid (*Hydroporus* sp.) were found. Nearly half of the true bugs consumed were water boatmen. About 6 per cent consisted of ants, bees, wasps and leaf-hoppers.

The stomach of one trout, 9.8 inches long, from Bright Dot Lake contained an adult Sierra Nevada yellow-legged frog (*Rana boylei sierrae*). On September 10, 1937, an occasional trout was seen pursued by others, swimming toward deeper water with one of these frogs held crosswise in its mouth, attempting to swallow it.

SUMMARY

In summary, golden trout planted in two High Sierra lakes, previously barren of fish, showed comparatively rapid rates of growth. Fish stocked in both lakes averaged 1.2 inches in length. Fish from Bright Dot Lake averaged 8.3 inches in length, about two years after planting, while fish in Bighorn Lake averaged 5.01 inches in slightly more than a year. The average condition factor for fish from Bright Dot Lake was 1.500; and that for fish from Bighorn Lake, 1.055. Only one winter check was found on the scales from trout that had lived two winters in Bright Dot Lake, and no winter check was found on scales of fish which had lived one winter in Bighorn Lake. Ninety-six per cent of all general foods found in the stomachs consisted of larvae and pupae of caddis-flies and midges. Water fleas and copepods formed over 99 per cent of plankton-crustacea eaten.

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LET'S GO FISHING¹

By RICHARD S. CROKER
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California has been termed an anglers' paradise. Although sometimes we may think differently after an unsuccessful day with rod and line, there really is good fishing to be had in our State. With more and more people coming to California as tourists and more of our residents turning to the out-of-doors for recreation, a growing interest in sport fishing is noted as evidenced by increases in angling license sales and in inquiries as to where to go fishing. In answer to these many requests for information, the following outline of fishing spots has been compiled. There are so many places to fish in this State that it would not be practicable to list them all; the outline includes only the better known ones, the places most likely to provide sport to the casual or visiting angler. The dyed in the wool fisherman already has his own favorite spots—the outline will do him no good although he can have the satisfaction of criticizing it because it omits his pet creek where he can always catch the limit.

The outline is divided into four parts, corresponding to the four principal kinds of fishing: ocean, bay, stream and lake. The section on ocean angling is further divided into two parts: boat fishing and shore fishing. Conditions are always changing—the outline applies to the 1938 season. The column headed "best months" represents average conditions; sometimes the best fishing will be as much as two months earlier or later than usual.

The person who wishes to go deep sea fishing and has no friend with a yacht can avail himself of any one of three kinds of craft that make a business of taking people fishing. These are charter boats that can be hired for a day (or a season), party fishing boats that leave daily on schedule for the fishing grounds, and anchored barges that are reached by tender boats. The various kinds of boats are to be found at nearly all southern and central California seaside towns, as shown in the outline. Bait, and in some cases tackle, are provided on the boats (tackle can always be rented). Prices per day are as follows:

Charter boats—\$20 to \$100, depending on size of party and size of boat; bait included.

Party boats—\$1.50 to \$5.00 per person, bait included.

Barges—\$0.75 to \$2.00 per person, bait included.

In general, the higher the price, the better the equipment and service. The standard prices in southern California are \$2 for party boats and \$1 for barges. Tickets at San Diego are \$3.50, of which \$0.50

¹ Submitted for publication, May, 1938. The writer wishes to acknowledge the help of Mr. A. C. Taft, Chief, Bureau of Fish Conservation, who kindly gave his advice on the fresh-water section.

is the license fee for fishing in Mexican waters, where the boats generally run.

Shore fishermen will find bait and tackle stands at all seashore towns. Nearly every pier has its stand, which usually has live bait for sale and tackle for rent.

Most of the enclosed bays along the California coast furnish good fishing. The most popular fishing area of the entire State is San Francisco Bay, where thousands of striped bass anglers try their luck every week of the year.

All the bays listed below afford shore fishing, and skiffs can be rented at one or more points on every bay at a cost of \$0.75 to \$1.50 a day. Charter boats are available at nearly every town on San Francisco Bay and tributaries at \$12 and up per day for parties of several people. The charter boats, and even some of the fleets of skiffs, follow the runs of fish so that local inquiries are advisable. For instance, most of the charter boats can be found at San Francisco, Berkeley, Richmond and Marin County points during the spring and early summer, but they all move up the bay to Martinez and Port Chicago for the fall fishing. Bait and tackle can be purchased at all towns and resorts located on the bays listed below.

Open bays, such as Santa Monica Bay and Monterey Bay, are discussed in the section on ocean fishing.

Most popular of all kinds of angling in California is stream fishing for trout. There are so many miles of fishable rivers and creeks in our State that mention of the total mileage would be taken as an exaggeration. Only the most important river systems are listed in the outline below; space forbids including them all.

The outline is divided into sections corresponding to the major drainage basins. The section headed "Southern California Streams" includes the rivers and creeks south of the Tehachapis, most of which are too small to warrant discussion. There are several streams flowing eastward from the Sierra Nevada. These are also discussed separately. Most of the fishing on the East Side, however, is lake fishing. The streams of the Sacramento-San Joaquin Valley drainage system (the Central Valley) are of the greatest importance. Flowing down from the Sierras and other mountain ranges, these rivers are excellent trout streams. In their lower reaches, in the foothills and on the floor of the valley, they are notable striped bass, black bass and salmon waters. Most of the better known of these rivers are listed in the outline, but there are others equally as good. The last section lists the most important of the rivers draining into the ocean along the northern coast of the State. Included among these is the Klamath River, most famous of all our rivers from the angler's standpoint. Fishermen come from all over the world to catch the steelhead and salmon of the Klamath.

California trout streams are generally fished from the banks or by wading—they are too swift and turbulent for boat fishing. Along the lowland streams, bank fishing and boat fishing are both popular. Skiffs can be rented at many places for about \$1 a day.

The Sacramento-San Joaquin Valley with its slow moving rivers and the delta country (the region downstream and west of Sacramento and Stockton) with its network of sloughs and rivers comprise one of the finest fishing areas of the State, with a great variety of fish to be

caught. Of all the game fish of this region, the striped bass is best known. During the summer months, angling for the so-called spiny-rayed fishes (large- and small-mouthed black bass, crappie, calico bass and bluegill sunfish) yields good results, and this type of fishing is becoming more popular every year. Catfish are sought by great numbers of "cane-pole fishermen," and the annual salmon runs provide splendid sport. Incidentally, the striped bass, black bass, crappie, calico bass, sunfish and catfish are all non-native species, having been introduced from the eastern United States. The only native spiny-rayed fresh-water fish of the State is the Sacramento perch, which is a highly prized game fish but rather scarce.

There are two general kinds of fishing on the North Coast rivers—in fact on all the coastal streams from the Sur River north (including those not specifically mentioned). These are: salmon and steelhead fishing in the estuaries or near the river mouths during the fall and winter, and fishing for the young steelhead trout farther upstream during the summer. Steelhead and salmon are also caught upstream in the Klamath, Eel and Russian rivers during the fall and winter. Skiffs can be rented on most of the coastal rivers for \$0.75 to \$1.50 a day. Guides and boatmen can also be engaged on the Klamath and some of the other rivers.

There are many thousands of lakes in California containing fish. In many parts of the State, in fact, fishing means lake fishing and nothing else. Obviously, all these lakes can not be mentioned by name. However, not all the lakes of the State provide fishing; anyone planning a trip just by looking at a map and noting the large lakes would be disappointed in some of them. There is no angling in Salton Sea, Owens Lake or Mono Lake, for instance. Due to reclamation and a succession of dry winters, there has been little or no water for years in Buena Vista and Tulare lakes, but the heavy rains of the last two years have filled the lakes and there may again be fishing in them. There are several large lakes in the northeastern corner of the State which would not yield any returns to the angler: Honey Lake, Goose Lake, Tule Lake, Lower Klamath Lake, and others. On the whole, though, nearly every natural lake and reservoir will repay a visit with a catch of fish.

It is possible to rent skiffs at \$1 to \$2 a day on practically every lake that is reached by automobile road (and some others reached only by trail). On some municipal and private reservoirs, a \$0.50 permit fee is charged.

In the following outline, the many hundreds of High Sierra lakes are not segregated—there are too many of them, nearly all with good fishing: Convict Lake, Mammoth Lakes, Virginia Lakes and all the others from Mt. Whitney north to Lake Tahoe. The lakes, at elevations of 5000 to 12,000 feet, can be reached from either the east or west sides of the mountains. Similarly there are many small lakes north of Lake Tahoe and in the Siskiyou Mountains of northwestern California.

OCEAN FISHING

Place (south to north)	Kinds of fish	Best months	Fishing methods and facilities
BOAT FISHING— San Diego (fishing principally at Coronado Islands, Mexico)			
Oceanside	Yellowtail, bluefin tuna, yellowfin tuna, marlin, broadbill swordfish, white-sea-bass, bonito, barracuda, rock bass, halibut, black sea-bass	April-September	Trolling for marlin and swordfish, live bait for others. Party boats, charter boats, barge
San Clemente	Yellowtail, barracuda, rock bass, white sea-bass, halibut, bonito, mackerel	May-September	Live bait fishing. Party boats and barge
Newport-Balboa (some boats run to Catalina)	Yellowtail, barracuda, rock bass, white sea-bass, halibut, bonito, mackerel	April-September	Live bait fishing. Party boats and barge
Huntington Beach	Barracuda, yellowtail, tuna, albacore, marlin, white sea-bass, black sea-bass, bonito, rock bass, halibut, mackerel	April-October	Live bait fishing and trolling. Party boats, charter boats, barge
Catalina Island (Avalon)	Barracuda, white sea-bass, black sea-bass, halibut, bonito, mackerel	May-September	Live bait fishing. Party boats
Long Beach and San Pedro (some boats run to Catalina)	Yellowtail, barracuda, albacore, bluefin tuna, yellowfin tuna, marlin, broadbill swordfish	Barracuda and yellowtail: May-September Other species: August-September	Live bait fishing and trolling. Charter boats, barge
Santa Monica Bay towns: Redondo Beach, Hermosa Beach, Malibu	Barracuda, yellowtail, tuna, albacore, marlin, white sea-bass, black sea-bass, bonito, rock bass, halibut, mackerel	April-October	Live bait fishing, trolling. Party boats, charter boats, barges
Pt. Mugu	Halibut, white sea-bass	May-September	Live bait fishing. Party boat, charter boats, barge
Avila	Rockfish, cuttus	June-September	Artificial lures. Party boats, charter boats
Cayucos	Rockfish, cuttus	June-September	Artificial lures. Party boats
San Simeon	Rockfish, cuttus	June-September	Artificial lures. Party boats
Monterey	Rockfish, salmon, cuttus, mackerel	April-September	Trolling for salmon, cut bait for others. Party boats, charter boats
Santa Cruz and Capitola	Rockfish, salmon, cuttus, mackerel	April-September	Trolling for salmon, cut bait for others. Party boats, charter boats
Pedro Pt. (Rockaway Beach)	Salmon, rockfish, cuttus	March-October	Trolling and cut bait. Party boat and skiffs
San Francisco	Salmon, rockfish, cuttus	March-October	Trolling. Charter boats
Sausalito	Salmon, rockfish, cuttus	March-August	Trolling. Charter boats
Bodega Bay	Salmon, rockfish, cuttus	Summer	Trolling. Charter boats
North to Oregon	Very little fishing, sometimes commercial salmon fishermen will allow anglers on their boats	June-August	Trolling
SHORE FISHING (including surf, piers and rocks)— From Mexican border to Santa Barbara			
Pismo Beach to Santa Cruz	Corbina, spottin croaker, yellowfin croaker, surf perch, sharks and rays. Also barracuda, bonito, halibut, mackerel, white sea-bass from piers	April-October; some fishing all year	Casting with bait: mussels, sand crabs, pile worms. Also live bait from piers. Piers are located at: Mission Beach, La Jolla, Del Mar, Oceanside, San Clemente, Balboa Beach, Newport Beach, Huntington Beach, Seal Beach, Long Beach, Terminal Island, San Pedro (breakwater), Redondo Beach, Hermosa Beach, Manhattan Beach, Hyperion, Venice, Ocean Park, Santa Monica, Malibu Beach, Pt. Mugu Hueneme, Santa Barbara
Pismo Beach to Santa Cruz	Rockfish, surf perch, halibut, sea-trout	All year	Bait: mussels, clams, sardines. Piers are located at: Pismo Beach, Avila, Cayucos, San Simeon, Monterey, Moss Landing, Capitola, Santa Cruz
Princeton to Bolinas	Striped bass, rockfish, surf perch, sea-trout	All year	Bait: mussels, clams, sardines. Piers are located at: Princeton, Bolinas
Pt. Reyes to Oregon	Rockfish, surf perch, sea-trout	All year	Bait: mussels, clams, sardines. Piers are located at: Pt. Reyes, Crescent City

BAY FISHING

Place (south to north)	Kinds of fish	Best months	Fishing methods and facilities
Mission Bay.....	Spotfin croaker, yellowfin croaker, sharks, rays.....	April-October.....	Cut bait from shore, bridges or skiffs: clams, mussels, sardines, anchovies. Skiffs available
Balboa Bay (Newport Harbor).....	Spotfin croaker, yellowfin croaker, halibut, sharks, rays.....	April-November.....	Cut bait from shore or skiffs: clams, mussels, sardines, anchovies. Skiffs available
Anaheim Landing.....	Spotfin croaker, yellowfin croaker, sharks, rays.....	April-November.....	Cut bait from shore or skiffs: clams, mussels, sardines, anchovies. Skiffs available
Other bays from San Diego to Ventura.....	Same general conditions.....		
San Francisco Bay, San Pablo Bay and tributaries (Petaluma Creek, Richardson's Bay, etc.).....	Striped bass, salmon, perch, flounders, rockfish, sharks, rays.....	February-August.....	Trolling, cut bait (sardines) from boats, wharves and shore. Skiffs and charter boats available at all towns on north San Francisco Bay, San Pablo Bay and tributaries
Suisun Bay, Carquinez Strait and tributaries (Napa River, Montezuma Slough, etc.). For Sacramento-San Joaquin rivers, see River Fishing.....	Striped bass, salmon.....	All year, varying in the different local fishing areas.....	Trolling, cut bait (sardines) from boats, wharves and shore. Skiffs and charter boats available at many points
Bolinas Bay.....	Striped bass, smelt.....	Summer.....	Cut bait (sardines, pile worms). Skiffs available
Tomales Bay.....	Salmon, striped bass, sharks, rays.....	Salmon: November-December. Bass: summer.....	Salmon: trolling. Bass: cut bait (sardines). Skiffs available

RIVER FISHING (Name of River includes Tributaries and Forks)

Place (south to north)	Kinds of fish	Best months	Fishing methods and facilities
SOUTHERN CALIFORNIA STREAMS—			
San Jacinto River.....	Rainbow trout, Loch Leven trout.....	May-July.....	Bait, fly, spinner
Santa Ana River.....	Rainbow trout, Loch Leven trout.....	May-July.....	Bait, fly, spinner
San Gabriel River.....	Rainbow trout, Loch Leven trout.....	May-July.....	Bait, fly, spinner
EAST SLOPE OF SIERRAS—			
Owens River.....	Loch Leven trout, rainbow trout, golden trout.....	July-August.....	Fly, spinner, bait
Walker River.....	Cut-throat trout, rainbow trout, golden trout.....	July-August.....	Fly, spinner, bait
Carson River.....	Cut-throat trout, rainbow trout, golden trout.....	July-August.....	Fly, spinner, bait
Truckee River.....	Rainbow trout, Loch Leven trout.....	June-September.....	Fly, spinner, bait
CENTRAL VALLEY RIVERS—			
Kern River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait
Kaweah River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait
Kings River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait
Upper San Joaquin River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait
Merced River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait
Tuolumne River.....	Trout, principally rainbow.....	June-September.....	Fly, spinner, bait

Stanislaus River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
American River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
Yuba River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
Upper Feather River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
Pit River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
Upper Sacramento River.....	Trout, principally rainbow	June-September.....	Fly, spinner, bait
LOWLAND STREAMS OF CENTRAL VALLEY—			
San Joaquin River and connecting rivers and sloughs (Old River, Middle River, Mokelumne River, etc.)	Striped bass, black bass, crappie, calico bass, sunfish, salmon, catfish	Striped bass: May-October Black bass, crappie, calico bass, sunfish: June-October Salmon: September-October	Striped bass: trolling, bait (sardines) Black bass: plugs, flies, spinners, live bait Crappie, calico bass, sunfish: flies, spinners, live bait, worms Salmon: trolling, spinner casting Catfish: cut bait (sardines), worms Skiffs available at numerous points
Sacramento River and connecting rivers and sloughs (Steamboat Slough, Three-mile Slough, etc.)	Striped bass, black bass, crappie, calico bass, sunfish, salmon, catfish	Striped bass: May-October Black bass, crappie, calico bass, sunfish: June-October Salmon: September-October	Striped bass: trolling, bait (sardines) Black bass: plugs, flies, spinners, live bait Crappie, calico bass, sunfish: flies, spinners, live bait, worms Salmon: trolling, spinner casting Catfish: cut bait (sardines), worms Skiffs available at numerous points
Feather River.....	Striped bass, black bass, salmon, catfish.....	Striped bass: May-October Salmon: September-October Black bass: summer	Striped bass: trolling, bait (sardines) Black bass: plugs, flies, spinners, live bait Salmon: trolling, spinner casting Catfish: cut bait (sardines), worms Skiffs available at numerous points
NORTH COAST STREAMS—			
Russian River.....	Salmon, steelhead, black bass, striped bass.....	Salmon and steelhead: October-January Black bass: summer	Salmon: spinner casting and trolling Steelhead: spinner casting, flies, salmon eggs Black bass: plug and spinner casting Striped bass: trolling and sardine bait Skiffs available at several points
Gualala River.....	Silver salmon, steelhead trout.....	November-January.....	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, flies, salmon eggs Skiffs available
Garcia River.....	Silver salmon, steelhead trout.....	November-January.....	Salmon: spinner casting Steelhead: spinner casting, salmon eggs, flies
Navarro River.....	Silver salmon, steelhead trout.....	November-January.....	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, salmon eggs, flies Skiffs available
Noyo River.....	Silver salmon, steelhead trout.....	October-December.....	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, salmon eggs, flies Skiffs available

RIVER FISHING (Name of River includes Tributaries and Forks) — Continued

Place (so far to north)	Kinds of fish	Best months	Fishing methods and facilities
Ten Mile River	Silver salmon, steelhead trout	October-December	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, salmon eggs, flies Skiffs available
Mattole River	Silver salmon, steelhead trout	October-December	Salmon: spinner casting Steelhead: spinner casting, salmon eggs, flies
Eel River	Silver salmon, steelhead trout	October-December	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, salmon eggs, flies Skiffs available
Redwood Creek	King salmon, silver salmon, steelhead trout	September-October	Salmon: spinner casting and trolling Steelhead: spinner casting, trolling, salmon eggs, flies Skiffs available
Klamath River	King salmon, silver salmon, steelhead trout	August-October	Salmon: spinner casting and trolling Steelhead: spinner casting, flies, trolling, salmon eggs Skiffs and guides available
Smith River	King salmon, silver salmon	September-November	Trolling and spinner casting. Skiffs available

LAKE FISHING

Place (south to north, in general)	Kinds of fish	Best months	Fishing methods and facilities
Ten lakes in San Diego county	Large-mouthed black bass, crappie and bluegill (largest crappie and bluegill in United States)	All year (closed seasons on various lakes are staggered)	Plug casting, flies, live bait, worms, etc. Skiffs available
Big Bear Lake	Trout, large-mouthed black bass	May-October	Casting, trolling, bait. Skiffs available
Arrowhead Lake	Rainbow trout	May-October	Trolling, bait. Skiffs available
High Sierra lakes	Rainbow, Loch Loven, cut-throat and eastern brook trout; golden trout in lakes above 10,000 feet	July-August	Spinner, fly, bait, trolling. Skiffs available on nearly all lakes reached by road and at some reached only by trail
June Lake	Trout	June-August	Spinner, bait, trolling. Skiffs available
Huntington Lake	Trout	June-September	Spinner, bait, trolling. Skiffs available
Bass Lake	Trout, black bass	June-September	Spinner, bait, trolling. Skiffs available
Lake Tahoe	Trout, black bass	June-September	Spinner, bait, trolling. Skiffs available
Clear Lake (Lake County)	Black bass, crappie, bluegill, catfish	All year	Trolling. Skiffs and charter boats available
Lake Almanor	Trout	June-September	Plug casting, trolling, bait. Skiffs available
Lakes of extreme northern California	Trout in small lakes; no fishing in large lakes of northeastern California	June-September	Spinner, bait, trolling. Skiffs available
			Spinner, fly, bait, trolling. Skiffs available on nearly all lakes reached by road

EDITORIALS AND NOTES

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No. 3



E. L. McKenzie



Raymond Grey



Newton G. Booth, Jr.

CHANGES IN PERSONNEL OF THE FISH AND GAME COMMISSION

There have been several recent changes in the personnel of the California Fish and Game Commission. In March, 1938, Mr. A. T. Jergins of Los Angeles resigned his post as commissioner. In April, Governor Merriam appointed three new commissioners, one to take Mr. Jergins' place, and two to fill additional posts created by the 1937 legislature. The new members of the commission are: Mr. E. L. McKenzie of Red Bluff, Tehama County; Mr. Raymond Grey of Taft, Kern County; and Mr. Newton G. Booth, Jr., of Harbin Springs, Lake County. Dr. E. C. Moore of Los Angeles and Mr. I. Zellerbach of San Francisco are the remaining members of the commission, the former retaining the presidency. With the appointment of the new members, the commission is now at its full strength of five members for the first time.

Mr. Jergins was at all times a keen advisor, sincerely interested in the work. He will be missed by all on the Division staff. One of his deep interests was the establishment and organization of the Junior Game Patrol, for which he was responsible.

The new commissioners are all business men, well acquainted with the out-of-doors and interested in conservation work.—*Herbert C. Davis, Executive Officer, California Division of Fish and Game.*

NEW PATROL BOAT PLACED IN SERVICE

An addition was made to the marine patrol fleet of the California Division of Fish and Game on April 16, 1938, with the launching of the *Tuna* at San Francisco. This new cruiser is similar in general design

to the *Bonito* and *Marlin*, commissioned last year, but has a raised pilot house which gives the crew better visibility. The boat is 45 feet long, with 10-foot beam and is powered by twin gasoline engines. Sleeping accommodations are provided for two men, and large fuel tanks will enable the boat to make extended trips from its home station at Avalon, Santa Catalina Island.—*E. L. Macaulay, Chief, Bureau of Patrol, Division of Fish and Game, May, 1938.*



FIG. 100. The launching of the new patrol cruiser *Tuna*. Left to right: Warden Carmi Savage, captain of the boat; Miss Katherine Karmelich, sponsor; Mr. H. C. Davis, executive officer of the Division of Fish and Game; Assistant Warden Karl Lund, assigned to the *Tuna*. Photograph by E. L. Macaulay.

VOLUNTARY CLOSED SEASON FOR MACKEREL CANNING

Studies conducted at the California State Fisheries Laboratory indicate decided depletion of the supply of mackerel, and the seriousness of the situation has been discussed with fishermen and cannerymen by staff members of the Laboratory. Any legal restriction of mackerel fishing passed at the next session of the Legislature would not be operative until the late summer of 1939, so if anything was done before that time it would have to be accomplished by the men of the mackerel canning industry. The proposal was made that the mackerel cannerymen and fishermen voluntarily impose upon themselves a closed season and this met with unanimous agreement on the part of all cannerymen and the fishermen's organizations that were consulted. The final agreement was that no mackerel should be delivered or accepted for canning anywhere in the State during the two calendar months of April and May. This voluntary restriction upon canning was lived up to strictly during April and May of 1938.

This curtailment of the mackerel catch is not sufficient to play a very important part in building back the ocean stock to its former level of productivity nor will it necessarily prevent further depletion during future months open to mackerel fishing, but the closed season is a step in the right direction and the voluntary agreement demonstrates a spirit of cooperation on the part of the industry and a genuine interest in safeguarding the future of the mackerel supply. There have been other examples in this State of voluntarily imposed restrictions in our fisheries industries, but we believe this is the first state-wide self-imposed closed season involving such a financial sacrifice on the part of packers and fishermen.—*W. L. Scofield, California State Fisheries Laboratory, May 20, 1938.*

MUST THE SCIENTIST ALWAYS BE ON THE DEFENSIVE?

EDITOR'S NOTE.—The following editorial was submitted by one of the research workers of the California Division of Fish and Game, who prefers to remain anonymous. Although it is not our policy to publish unsigned articles, we feel that this editorial should be presented for the consideration of our readers.

The accepted criterion which distinguishes man from the so-called lower animals is the superior development of his brain. During the vast stretch of time when man was slowly differentiating from the other animals, the brain was apparently merely a depository for accumulating impressions of the natural environment in which he found himself—and queer reactions some of those impressions must have produced. As time went on, there appeared men whose brain cells were superior or at least more active than those of their fellows. These accomplished individuals were not satisfied merely to absorb impressions; they analyzed them and at once found themselves in hot water. Their reasoning and conclusions tended to show and sometimes to prove that many beliefs and prejudices, backed by tradition, were either false or ridiculous or both. From that early beginning up to and including the present time, workers in the field of the natural sciences have been on the defensive. Man is a conservative and resents any departure from accepted tradition. He also resents being made ridiculous. People will go to absurd lengths to defend a premise which they have endorsed after accepted facts and even their own common sense have proved that it is false.

An understanding of these inherent traits, products of ancient impressions, makes it at once apparent that Galileo was simply asking for trouble when he discoursed on the solar system, that Vesalius unleashed a tremendous blast of vituperation by proving that men and women have the same number of ribs, and that Spallanzani, a pugnacious individual by contrast, was forced to defend belligerently his demonstration that spontaneous generation was a myth. These illustrations and many others are cited in our day with tolerant amusement as indicative of man's ignorance in his infancy, the supposition being that he has now reached maturity. Observation, however, does not substantiate this optimistic assumption. At any rate the biologist is still on the defensive.

The present human environment is largely artificial but to maintain himself, man is compelled to recognize the existence of a vast number of other organisms that live in an environment which is still natural,

except where man has meddled with it. We call the study of these organisms biology, and the attempted manipulation of the natural environment conservation. In its broadest sense conservation means the management of natural resources to the end that they will continue to yield food and material for human needs without jeopardizing the basic supply. The biologist is conceded a definite position in this attempt to adjust organisms and ecological conditions to human necessities. He is encouraged to investigate the workings of natural laws and their application to human welfare, but almost without exception a natural law which does not conform to tradition is roundly denounced along with the man who discovers it. Even when no tradition or prejudice is controverted, biological work is regarded with suspicion as it is something beyond the ken of the ordinary man, who generally has only a very vague idea of the structure and functions of his own body.

Although the average citizen is largely dependent on the natural environment and its inhabitants he knows little or nothing about it. He delegates to governmental bodies the task of conserving his natural resources. The various governmental subdivisions employ trained men to acquire the necessary information by which their policies are determined. Because of their familiarity with special fields, these departments are able to present information to legislative committees and law courts for the guidance of these bodies, but at that point we run into our old friend tradition again. Having presented the results of his labors the biologist can not defend them. He must remain in the background as a spectator while lawyers, business men and others question his disinterest, deliberately misinterpret plain statements and befog simple issues with soaring flights of oratory, which admittedly are sometimes much more effective in gaining the end sought than detailed facts and cold logic. It is only fair to admit however that most biologists would not defend themselves or their work under such circumstances if it were traditionally permissible. There are not many Spallanzanis and Huxleys. With few exceptions, scientific workers can not be reached by politics or money as they set no value on power or wealth but value highly their scientific reputation. What does it matter if their work is minimized or altogether suppressed by political log rolling? They go back to their work, content that they have done their job, done it well and added to their own stock of knowledge—and that is about the only reward they generally receive or want.

To demonstrate that this is not idle speculation, suppose we examine an actual case, which is one of many. During a recent fisheries investigation a great deal of testimony was written into a report of a congressional committee and a fifteen-page pamphlet (in fine print) was appended. The pamphlet was in the interests of operators who were seeking to escape governmental supervision and to secure a more extensive exploitation of sardines, in opposition to the biologists' claims that more extensive fishing might deplete the supply. This pamphlet is of interest. In the first place it was written by an attorney who used it as the basis for his testimony before the committee. Although many of the statements are half truths, there is an impressive show of data to support a conclusion diametrically opposed to that of the biologists, but on analysis most of the figures not obviously gleaned from official reports have all the earmarks of good guessing. There are many quota-

tions which appear very convincing, but a perusal of the scientific reports from which they were taken shows that most of them are half quotations or they have been cleverly placed in different settings, which altogether change their meaning. The writer refers to "pseudo-scientists" and sarcastically to "experts" in speaking of men who have devoted their lives to the study of a subject, about which he admittedly knows nothing. He announces that it is his opinion that this or that biological conclusion is erroneous and that his clients are being persecuted by a lot of "hired propagandists" and "political scientists." This should prove to any intelligent person that the sardines can not be depleted. After all, our attorney has nothing to lose. It is all a part of the game from his viewpoint and by speaking (and writing) with a voice of authority, he may and probably will convince many people that the interests he serves are persecuted benefactors of the race. He is considered clever if he wins his case and no stigma attaches to him if he loses. He says that a "thing is so" when the biologist says "it appears to be so," as our scientific man must always protect himself by demonstrable facts. Even if he were not influenced by the ethics of his calling, his fellows are a critical and heavy handed lot. A few bad mistakes, a hint of charlatanism and his reputation is ruined.

It is of interest to note that the issue involved in the above mentioned investigation was so befogged by oratory and appeals to the emotions that no definite action was taken and now, after a lapse of two years, the depletion of the fishery predicted by the biologists has reached serious proportions.

Suppose we have a look at "predatory animal control," another highly controversial subject, about which the biologist voices a conviction at his peril. To champion **any** species of mammal, bird or fish that tradition places on the "black list" is on a par with proclaiming yourself an Orangeman in a meeting of the Hibernian society. The sportsman, the farmer and the general public maintain fixed convictions in respect to the relationship between so-called predators and "game." A few casual observations are all that is necessary for confirmation. Yet the biologist who has the temerity to defend any predator must produce exhaustive and incontestable data to clear himself of the taint of heresy, and even then any future work he may do is viewed, at least by laymen, with suspicion because he has dared to contradict an established prejudice. This attitude is so pronounced that much worthwhile work is buried in obscure scientific journals where it will be reasonably safe from lay observation, or remains unpublished. In the meantime the sportsman and the farmer proceed to eliminate "predators" at every opportunity, failing to make a distinction between the harmful and the really beneficial species. The results are sometimes deplorable. The "game" animals and birds, in many cases, are not in the least benefited and sometimes are actually harmed, while the people are forced to spend enormous sums of money in an endeavor to check real pests such as ground squirrels, rats and insects—a task which constituted the life work of most of the late and unlamented "predators."

This discussion, with concrete cases, could be prolonged but enough has been said to indicate our meaning. So the next time you cut yourself badly and the doctor uses some new-fangled disinfectant, don't start an argument with him over the relative merits of the boiled cow

dung and spider webs your great grandmother used in contrast to his germ killer. Also, the next time you encounter a sportsman with his gun and his limit of quail, don't shoot him. He is a predator, of course, but for all you know he may be a good husband, a kind father and a worthy citizen.

RADIO TELEPHONES ON FISHING BOATS

During the 1936-37 sardine season a few purse seine boats were equipped with radio telephones. Their value as an aid to the fishermen was soon recognized. Several more local purse seiners seeking tuna in Mexican waters the following summer added radio telephones to their equipment. At the present time roughly one-third or about seventy-five of the purse seine boats on the Pacific Coast are equipped with sets. Practically all of the remaining boats have radio receivers so they can pick up information sent to other boats, but can not themselves broadcast. Many more sardine boats will install radio telephones before the next sardine season (1938-39).

Prior to the introduction of radio telephones on fishing boats, fishermen hesitated to reveal the location of their catches. The first boats to obtain transmitters even went as far as to agree on prearranged codes for the names of localities. In this way they could tell their friends where they were finding fish and at the same time mislead others. This system was soon found quite unsatisfactory, so that now all boats are glad to give information to anyone in exchange for similar information.

Since sardine, tuna or mackerel schools travel from place to place the boats finding fish tell the other boats so that they may move into areas where fish are known to be present. Previously a boat would often scout for days without finding fish or knowing where fish were being caught. Frequently, such boats would return to port to question other fishermen unloading their vessels. This was not only time consuming but information thus obtained was often unreliable due to the traditional reluctance of the fisherman to have others fish where he does. Radio telephone is especially helpful to purse seiners going down into Mexican and Central American waters for tuna, as they scout over several hundred square miles while fish frequently "show" only in very localized areas.

Besides broadcasting fishing conditions, the sets are valuable in disseminating weather information. Business is often transacted over the air and not infrequently fishermen notify worrying families that they are in a snug anchorage during a blow. Fish dealers, canneries and reduction plants can be notified as to when to expect fish. They then know when and how large a crew to call, so that no time is wasted in unloading and processing the catch. In case of engine breakdowns or other trouble, aid may be summoned by calling a Coast Guard station or the nearest telephone company station. In case of injury to a crew member, medical advice can be asked and not infrequently Coast Guard planes have responded to reports of serious accidents by taking doctors to the scene.

Drag boats fishing for bottom fish off central and northern California find the radio telephone useful for the same reasons as do the purse seiners. Furthermore, the companies operating these boats can direct their boats to deliver their fish at different ports; or tender boats

can be notified as to their location and pick up catches of several boats, thus saving the individual vessels a trip to port and back to the fishing grounds.

In southern California, boats taking out sport fishing parties have found radio telephones a decided asset to their business. Frequently one company operates several boats. Each boat will go to a different place but keep in contact with the others by air. If one boat gets into considerably better fishing than any of the others, those which are having poor luck go to the more fruitful areas.

Radio telephone has therefore raised the efficiency of our fishing fleet and thereby increased the fishing intensity.

Nothing has brought the fishermen together into a close fraternal group more than the radio telephone. They have dropped their old secretive traits to a large extent and are more anxious than ever to help the other fellow as they know they will get the same in return. At times it is illuminating to "tune in on the boats," as interesting or humorous conversations frequently go over the air. Any home radio within range and equipped to receive short waves can hear the fishing fleet on 2738 kilocycles (other frequencies are used for ship-to-shore communication).

The cost of complete radio telephone equipment installed in a boat ranges from \$300 to \$1,000. The power outputs of most fishing boat sets range from 15 to 50 watts, the average transmitter being 25 watts. The range of an instrument varies considerably, depending upon the boat's location and meteorological conditions. The usual daytime range of the average transmitter is from 150 to 200 miles. Under unusually favorable conditions, the night range is practically unlimited whereas under exceptionally adverse conditions little more than ten miles can be reached. However, this low limit is rather infrequent.

Telephone companies operate three shore stations on the Pacific Coast through which land connections to any telephone may be made: KOW at Seattle, KLH at San Francisco, and KOU at San Pedro. Rates are reasonable. If the boat is within a radius of 150 miles of the shore station the charge is \$1.50 for three minutes and \$0.50 for each additional minute. For any distance over 150 miles from the shore station the toll is \$3 for three minutes and \$1 for each additional minute. If it is necessary to make a long distance connection between the telephone company's station and the party ashore, the land toll is added to the cost. One-third of the radio linkage charge (not including land toll) is paid to the owner of the boat. If the boat phones someone ashore, the rate is therefore one-third less; if someone ashore phones the boat, the boat makes one-third of the land-to-boat toll. This is merely an inducement on the part of the telephone companies to encourage the ship-to-shore convenience they offer. Two boats can, of course, talk to one another without cost. It is only when messages are sent through commercial shore stations and telephone wires that tolls are charged. The Federal Communications Commission does however require that one man on each boat carrying radio telephone be licensed. The examination for a license is such that anyone familiar with the standard routine of simple radio telephone operations can easily pass it after a little coaching by someone already licensed to operate a set.—*John F. Janssen, Jr., California State Fisheries Laboratory, May, 1938.*

AIR BUBBLES AS A FISH SCARE

When a purse seine is set around a school of sardines or tuna the fish frequently sound in an effort to evade their captors. If the net is pursed before the school sounds, the force of tons of fish making a desperate effort to go through the bottom of the net frequently splits the webbing and the fish escape. Often, part of the school sounds, carrying the cork line beneath the water while the rest of the school swims over and away.

A simple and ingenious method was used by a few fishermen during the 1936-37 sardine season to discourage the fish from sounding. It is quite successful and its use has spread during the 1937-38 season. The device consists merely of a long rubber hose through which a small stream of air is forced. The hose measured on one boat was $\frac{5}{8}$ -inch in diameter with a $\frac{3}{16}$ -inch hole. A few lead weights are fastened near the end of the hose to sink it. When fish threaten to sound, the fishermen turn on the air and drop the hose over the side so the end reaches the bottom of the net. The stream of bubbles rising in the water is an effective scare and the fish come back to the surface.

Before a sardine or tuna net is pursed, the fish frequently escape through the opening beneath the boat. To keep the fish well back into the net, the air hose is hung over the side and air blown into the water till the net is completely pursed. This method is especially useful in tuna fishing.

When large catches of sardines or tuna are made, the fish are bunched into two or more sections of the net and brailed out of each section separately. In such a case the school can be "split" by trailing the end of the hose through the fish. The school separates where the bubbles are rising and part of the net is drawn up confining the fish in two sections. With tuna this may be repeated until the fish are in several bunches alongside the boat.

In Mexican and Central American waters sharks are a serious menace to tuna purse seines. When a set is completed, large sharks tear the webbing in an effort to get the impounded tuna. Fishermen frequently lower below the bag of their net a weighted can perforated with very small holes and filled with diesel oil. The small streams of oil slowly rising toward the surface tend to intimidate the sharks to some extent, but the method is not always entirely successful. It has recently been found that air serves the purpose a little better than oil and has the advantage of being very much easier to handle. A weight is attached to the air hose about one fathom from its end. The hose is then lowered alongside the impounded tuna, outside the net, till it is a short distance below the bottom of the net. The air rushing from the hose whips the free end beyond the weight, spreading the stream of bubbles over a considerable area and scaring the sharks away.

An ample supply of air under pressure is always available on purse seine boats, as compressed air is used to start their diesel engines. The air is usually piped to a jet on the port side of the deckhouse to which the hose is attached.

Frequently a short section of pipe closed at the end and perforated with many small holes is fastened to the end of the air hose to produce many small bubbles. This innovation does not seem necessary as satis-

factory results are obtained when the air is released from the free end of the hose.—*John F. Janssen, Jr., California State Fisheries Laboratory, March, 1938.*

RUBBER FLOATS FOR NETS

Since time immemorial fishermen have used wooden or cork floats to lend buoyancy to their nets. In 1936 a few sardine fishermen in southern California tried hollow rubber floats in place of some of the regular corks on their purse seines. These floats were shaped like the corks already in use but were slightly larger. They have been very satisfactory but their high price makes their use throughout a large net practically prohibitive. A number of purse seines, however, have them along the landing bag where corks split and break from chafing against boat and skiff. These rubber floats are not to be confused with the large balloon-like rubber or canvas floats (Scotch buoys, 12 to 24 inches in diameter) frequently fastened to the cork lines of purse seines.

Recently the rubber floats have been improved by manufacturing them with round instead of square edges and inflating them slightly. After injecting neverleak, air is applied through a self-sealing soft rubber valve.

The rubber floats have several advantages over corks. For one thing they do not become water-logged and a rubber float is more buoyant than a water-soaked cork. Rubber floats will not split and break and can stand no end of abuse. They have not been in use long enough to test their longevity but it is safe to say that they will last considerably longer than cork. If they prove to last long enough, their high original cost may consequently be offset. When setting a net, due to their smooth surface, rubber floats pay out without catching on webbing, gunwale or roller.

Rubber floats are made in two sizes: one, four inches long by seven inches in diameter for purse seines; and the other, oval in shape and looking much like wooden floats, is six inches long and four inches in diameter. The latter are used primarily on gill nets. Holes through the center are made in three sizes: $\frac{3}{4}$ inch, 1 inch or $1\frac{1}{4}$ inch in diameter. Special sizes of floats may be made to order.

The only company known to make rubber net floats at the present time is located in San Pedro. The manufacturer has applied for a patent.—*John F. Janssen, Jr., California State Fisheries Laboratory, April, 1938.*

REVIEWS

The Life Story of the Fish

By Brian Curtis; introduction by William Beebe. New York, D. Appleton-Century Co., 1938. 260 pp., 36 figs., index. \$3.

Reviewing this book places me in a somewhat difficult position. Because it is written by a friend and a fellow staff member of the California Division of Fish and Game, any glowing words of praise may be construed by the skeptic as so much "blarney." Be that as it may, it is only in superlatives that the book can be described. The reader is referred to countless reviews in scientific and semi-scientific publications—all of them more than favorable. Furthermore, "The Life Story of the Fish" was selected as the April, 1938, book-of-the-month by the Scientific Book Club—and April was a month of heavy competition.

The book was written primarily for anglers and aquarists, to give them easy access to the vast store of information on fish known only to scientists and stored in scientific laboratories and libraries. Usually attempts at sugar coating such difficult subjects as the life of the fish result in dismal failures—sentimental tommy-rot unacceptable to the public and biologists alike. In this case, however, the author has treated his subject with rare understanding, humor neither crude nor forced, facts neither dull nor insipid. Whoever reads the first chapter will not be satisfied to set the book down until he turns the last page, and that holds equally well for the laboratory technician, the field naturalist, the student of human life, the angler and aquarist for whom the book was intended, and the person who scarcely knows a fin from a scale but who appreciates beautiful writing.

The title well describes the contents; it is the life of the fish, from the egg to adult maturity. The text is divided into several convenient sections, each dealing with a phase of the life and structure of fish—all fish, from the most primitive to the most advanced (and incidentally the author explains what the ichthyologist means by "primitive" and "advanced"). At only one place does the author seem to go into too much detail; his account of the eyesight of fish is rather involved, though better than any other I have seen. The vision of a fish is a complicated and controversial subject and perhaps needs such full treatment.

The fishermen or fish fancier who reads this book can dumfound his less fortunate friends with his seemingly inexhaustible fund of sound information; he can answer questions that have stumped them all ever since the first angler cast a line and since primitive man discovered that he could keep fish in captivity.

This is one book that a reviewer can honestly say should be in the hands of every biologist, sportsman, nature lover and aquarist.—*Richard S. Croker, Editor, California Fish and Game.*

Giant Fishes, Whales and Dolphins

By J. R. Norman and F. C. Fraser. New York, W. W. Norton & Co., 1938. 361 pp., 8 col. pls., 97 figs. and many drawings, index. \$4.

This book is a scholarly yet readable account of an intensely interesting subject. It was prepared to answer the many questions asked of museums and laboratories by the public to whom large fish and whales are always intriguing.

The authors, outstanding authorities in their fields, are both of the Department of Zoology, British Museum. The book is divided into two parts: "Fishes" by Norman, and "Cetaceans" (whales and dolphins, or as we call them, porpoises) by Fraser. Both authors present their subjects in a highly commendable way, covering the vast field adequately but without unnecessary detail, relieving the formidable succession of facts with anecdotes and humor.

The section on giant fishes confines itself to the larger kinds of fishes of all parts of the world—the kinds that fishermen and others continually inquire about. The material and arrangement are excellent. Sizes of record fish are given wherever possible.

The section on whales and porpoises is especially useful, as little readable literature on this subject is available to the general public. Here also, interesting facts on life-history, distribution and size are well presented.

W. P. C. Tenison is responsible for the illustrations which are both accurate and entertaining. The reviewer particularly enjoyed the sketches at the beginning and end of each chapter.

This book should be in every general and specialized library and should prove a useful reference to every student of fish and whales. In the short time it has been in our library, we have had occasion to answer several inquiries through reference to it.—*Richard S. Croker, Editor, California Fish and Game.*

The Small-mouthed Bass

By Carl L. Hubbs and Reeve M. Bailey. Cranbrook institute of science, Bloomfield Hills, Mich. Bulletin, no. 10, 92 pp., 10 pls., 5 figs., January, 1938. \$0.75.

This little book is the answer—for one species—to a long felt want for concise general descriptions of American game fishes, suitable for angler, scientist and conservationist alike. It contains sections on the classification and identification of the small-mouthed bass (with a key to the black basses); brief descriptions of the closely related large-mouthed bass and spotted bass; distribution and habitat of the small-mouth; its hibernation; reproduction, development, age and rate of growth, food and parasites; and the senses of taste, smell, sight, hearing, touch and mass movement. Sections on angling and conservation round out the text, and there is a good bibliography.

Although pertaining entirely to conditions in the Middlewest and East, the book will be of considerable interest to California readers. Our State has many waters suitable for, and in fact containing, small-mouthed black bass, and the reader can make comparisons between local conditions and those described. As a matter of fact, a good deal of the

value of the book lies in the store of information on all fresh-water fish; especially interesting to the angler are the sections on the senses of fish.

In making a general presentation of the subject, the authors have done a good job. However, the style is just a little too formal and there are too many technical words for the sportsman-reader. On the other hand, the fish culturist who is accustomed to these terms will be on the lookout for specific facts to help him in his work—and will be disappointed. Nevertheless, this paper makes a fine attempt to bridge the gulf between the popular and the scientific sides of the story, and when all is said and done the result is certainly worth while.

It has long been the reviewer's contention that there is a real need for short popular accounts of the habits and life histories of our game fishes, and that these be made available to the sportsmen who are really interested in more than just catching fish. The book under review is perhaps the best step in this direction since the Province of Ontario issued a few short articles several years ago.—*Richard S. Croker, Editor, California Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1937, to March 31, 1938, of the Eighty-ninth Fiscal Year

Revenue for Fish and Game Preservation Fund:

License revenue:	Detail	Total
Angling, 1938	\$28,180 50	
Angling, 1937	387,779 35	
Commercial Hunting Club, 1937-38	900 00	
Commercial Hunting Club, operators, 1937-38	280 00	
Deer tags, 1937	120,880 00	
Fish breeders, 1937	365 00	
Fish importers license, 1937	100 00	
Fish packers and wholesale shellfish dealers	1,035 00	
Fishing party boat permits, 1937	308 00	
Game breeders, 1938	795 00	
Game breeders, 1937	117 50	
Hunting, 1937-38	393,528 27	
Hunting, 1936-37	20,000 50	
Kelp, 1937	30 00	
Market fishermen, 1937-38	44,810 00	
Trapping licenses 1937-38	2,563 00	
Total license revenue		\$1,001,672 12

Other revenue:

Court fines	\$34,849 88	
Fish packers tax	199,156 81	
Fish tags	2,712 64	
Game tags	200 34	
Interest on bank balances	712 73	
Kelp tax	187 33	
Lease of kelp beds	384 66	
Miscellaneous sales	4,705 37	
Publication sales	15 01	
Salmon tax	22,506 43	
Total other revenue		\$265,431 20
Total revenue for Fish and Game Preservation Fund		\$1,267,103 32

STATEMENT OF EXPENDITURES

For the Period July 1, 1937, to March 31, 1938, of the Eighty-ninth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures—89th Fiscal Year					
Administration:					
Accident and death claims			\$592 17		\$592 17
Cashier	\$750 00				750 00
Executive	3,749 94	\$186 44	1,922 97	\$919 13	6,778 48
Exhibits			1,200 00		1,200 00
General office	5,926 33	4,617 93	14,200 11	511 56	25,255 93
Legal			3,894 17		3,894 17
Library	1,350 00	28 14	109 55	326 73	1,814 42
Property inspection		21 44	95 85	12 05	129 34
Prorata Department Administration	7,519 99		6,000 00		13,519 99
Prorata General Fund expense			4,563 04		4,563 04
Publicity			2,022 82		2,022 82
Total Administration	\$19,296 26	\$4,853 95	\$34,600 68	\$1,769 47	\$60,520 36
Patrol and Law Enforcement:					
Cannery Inspection	\$17,359 41	\$874 33	\$2,299 74	\$266 48	\$20,799 96
Executive	10,665 00	627 02	1,928 06	65 28	13,285 36
General office	4,495 80	502 35	1,772 07	914 56	7,684 78
Junior patrol	1,946 02	259 58	493 15		2,698 75
Land patrol	140,242 82	27,635 95	47,447 56	21,723 25	237,049 58
Marine patrol	35,660 55	14,317 49	24,947 26	5,272 75	80,198 05
Pollution patrol	4,754 19	1,346 27	2,888 05	124 99	9,113 50
Total patrol and Law Enforcement	\$215,123 79	\$45,562 99	\$81,775 89	\$28,367 31	\$370,829 98
Marine Fisheries:					
Executive	\$5,490 00	\$156 42	\$343 60		\$5,990 02
Field supervision	2,420 00	225 01	1,643 02		4,288 03
Fish cannery auditing			1,411 75		1,411 75
General office	6,420 59	102 12	592 21		7,114 92
Research and statistics	28,327 36	2,635 13	7,960 65	\$1,448 82	40,371 96
Total Marine Fisheries	\$42,657 95	\$3,118 68	\$11,951 23	\$1,448 82	\$59,176 68
Fish Conservation:					
Cooperative research—Stanford University	\$2,344 67	\$242 68	\$484 60	\$67 82	\$3,139 77
Executive	4,770 00	169 99	434 30	1,012 70	6,386 99
Field supervision	7,532 48	826 08	2,763 92	1,388 86	12,511 34
Fish planting	2,601 22	1,121 02	1,714 86	4,334 24	9,771 34
Fish rescue	4,387 85	521 94	1,293 15	208 33	6,411 27
General office	3,516 40	92 29	52 33	324 71	3,985 73
Pollution inspection	2,340 00	237 40	543 34	1 17	3,121 91
Research	1,618 10	102 39	631 36	87 22	2,439 07
Statistical	1,710 00		764 00		2,474 00
Alpine	897 23	647 88	168 44	550 65	2,264 20
Basin Creek	3,231 76	1,899 41	411 46	541 78	6,084 41
Bear Lake Egg Collecting Station	100 00	72 81			172 81
Beaver Creek Egg Collecting Station	250 00		75 00		325 00
Beaver Creek	148 55	46 90	8 58		204 03
Big Creek	2,446 67	1,324 62	222 73	548 75	4,542 77
Blackwood	287 81	218 39	1 00		507 20
Blue Lakes Egg Collecting Station	400 00		16 00		416 00
Bogus Creek Egg Collecting Station	241 61	77 21	131 80		450 62
Brookdale	2,205 32	1,177 64	280 71	12 91	3,676 58
Burney Creek Hatchery	3,963 27	2,425 09	608 33	552 66	7,549 35
Carmen Lake Egg Collecting Station	312 00	2 24	10 43		324 67
Central Valleys	2,391 81	1,146 94	1,359 83	905 02	5,803 60
Cold Creek	2,492 27	1,783 31	617 71	579 48	5,472 77
Cottonwood Lakes Egg Collecting Station	83 87	11 10	75 23		170 20
Fall Creek Egg Collecting Station		29 21	85 00		114 21
Fall Creek	4,434 84	2,607 40	210 25	6 06	7,258 55
Feather River	2,929 55	1,772 17	319 80	193 23	5,214 75
Fern Creek	992 23	347 24	60 17		1,399 64
Fishing Creek Experimental Station	358 06	22 25	5 31		385 62
Forest Home	8,455 01	8,196 20	1,467 62	34 47	18,153 30
Fort Seward	2,938 71	835 96	102 65	682 38	4,559 70

STATEMENT OF EXPENDITURES

For the Period July 1, 1937, to March 31, 1938, of the Eighty-ninth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued:					
Hat Creek Egg Collecting Station		\$113 98			\$113 98
Hornbrook Egg Collecting Station	\$190 00	58 63	\$97 89		346 52
Hot Creek	2,183 56	1,956 63	162 05	\$5 06	4,307 30
Huntington Lake	246 00	253 15	156 40		655 55
Kaweah	3,422 90	1,309 59	985 70	141 90	5,860 09
Kings River	3,597 11	1,189 71	859 28	35 12	5,681 22
Klamathon Egg Collecting Station	1,412 91	121 48	324 58	12 21	1,871 18
Kosk Creek Egg Collecting Station		8 44			8 44
Lake Almanor	4,383 75	1,377 02	387 13	167 22	6,315 12
Lake Eleanor Egg Collecting Station		18 94			18 94
Little Walker Lake Egg Collecting Station	259 03				259 03
Madera	749 51	484 55	269 48		1,503 54
Marlette Lake Egg Collecting Station	713 17	4 79	56 90		774 86
Mt. Shasta Experimental Hatchery	781 29	493 82	28 09		1,303 20
Mt. Shasta	21,060 44	12,166 16	2,292 37	178 97	35,697 94
Mount Tallac	1,052 32	1,341 25	30 60		2,424 17
Mount Whitney	8,155 36	3,521 53	2,048 79	730 49	14,456 17
Mud Creek Egg Collecting Station	114 69	10 30		4 50	129 49
Pasadena Reservoir Egg Collecting Station	215 00	4 81			219 81
Prairie Creek	4,148 13	1,091 90	416 90	609 55	6,266 48
Rush Creek Egg Collecting Station	369 33	49 81			419 14
San Lorenzo Egg Collecting Station	8 00	128 72	1 00		137 72
Scott Creek Egg Collecting Station	1,125 00	81 77	114 89		1,321 66
Shackleford Creek Egg Collecting Station	226 00	35 16	70 00		331 16
Shasta River Egg Collecting Station	663 34	114 91	95 20	6 64	880 29
Shasta River Experimental Station	152 00	60 75	49 23		261 98
Snow Mountain Egg Collecting Station	1,200 00	112 26	105 17	19 68	1,437 11
Tahoe	4,285 35	1,367 44	498 22	57 37	6,208 38
Upper Truckee Egg Collecting Station	54 84				54 84
Waddell Creek Station	531 94	22 22	33 27		587 43
Warner Creek Egg Collecting Station	116 86	43 06			159 92
Yosemite	2,798 26	808 80	208 16	45 36	3,860 58
Yuba River	2,411 64	971 56	294 50	3 12	3,680 82
Total Fish Conservation	\$137,009 22	\$57,280 90	\$24,505 71	\$14,049 63	\$232,845 46
Hydraulics:					
Engineering	\$3,576 43	\$452 17	\$1,296 91	\$1,571 77	\$6,897 28
Executive	2,985 00	257 82	574 31		3,817 13
Fish screens	347 76	549 77	36 61	2,552 12	3,486 26
General office	1,440 00	78 40	88 60	201 16	1,808 16
Total Hydraulics	\$8,349 19	\$1,338 16	\$1,996 43	\$4,325 05	\$16,008 83
Game Conservation:					
Elk refuge	\$1,548 32	\$194 76	\$436 22	\$131 81	\$2,311 11
Executive	8,652 47	676 56	1,548 13	27 77	10,904 93
Field				17 06	17 06
Game bird distribution	800 00	478 42	339 76	16 06	1,634 24
General office	3,308 89	139 34	14 51	103 06	3,565 80
Grey Lodge Refuge	2,880 00	618 47	215 85	489 25	4,203 57
Imperial Refuge	1,350 00	105 34	66 69		1,522 03
Los Banos Refuge	2,307 87	467 30	485 33	47 22	3,307 72
Los Serranos Game Farm	9,732 90	4,332 54	1,923 49	2,327 37	18,316 30
Predatory animal control	23,546 35	3,628 98	9,663 03	1,183 24	38,021 60
Research	196 43	21 19	68 80	78 74	365 16
Statistics	842 74	57 97	828 87		1,729 58
Suisun Refuge	1,310 48	481 63	416 08	114 82	2,323 01
Winter feeding and salting of game		384 64			384 64
Yountville Game Farm	11,102 12	8,801 82	2,991 05	900 96	23,795 95
Total Game Conservation	\$67,578 57	\$20,388 96	\$18,997 81	\$5,437 36	\$112,402 70
Licenses:					
Executive	\$2,475 00	\$9 67	\$34 58	\$1,071 20	\$3,590 45
General office	1,063 67	132 22	1,706 48	2,093 90	4,997 27
License distribution	8,065 54	15,282 86	48,858 79	91 67	72,298 86
Total Licenses	\$11,604 21	\$15,425 75	\$50,599 85	\$3,256 77	\$80,886 58

STATEMENT OF EXPENDITURES

For the Period July 1, 1937, to March 31, 1938, of the Eighty-ninth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Special Item:					
Construction of research boat.....					\$3,000 00
Total Eighty-ninth fiscal year expenses, paid from supplementary appropriations.....					\$935,670 59
Expenditures for Additions and Betterments:					
Permanent Improvements:					
Purchase of game refuges and public shoot- ing grounds and C.I.E., Chap. 157-37.....	\$3,041 34	\$5,462 91	\$1,944 60	\$690 85	\$11,139 70
Contributions to Employees' Retirement Sys- tem.....					9,203 26
Total current biennium.....					\$956,013 55
Prior Biennium Appropriations:					
Eighty-ninth fiscal year:					
Special Item: Expenses of California Code Commission, Chap. 645-33.....					37
Eighty-eighth Fiscal Year:					
Special Item: Construction of Russian River Jetties, Chap. 989-33.....					365 84
Support:					
Eighty-eighth fiscal year.....					\$57,055 45
Eighty-seventh fiscal year.....					19 49
Total Support.....					\$57,074 94
Special Item: Predatory Animal Control:					
Eighty-eighth fiscal year.....					\$3,426 15
Expenditures for Additions and Better- ments, Permanent Improvements, Pur- chase of Game Refuges, and Public Shooting Grounds and C.I.E.:					
Eighty-eighth fiscal year.....					\$18,141 67
Total Prior Biennium Appropriations.....					\$79,008 97
Grand total.....					\$1,035,022 52

SEIZURES OF FISH AND GAME

January, February, March, 1938

Game:

Brant, black sea	5
Canary, wild	3
Coot	1
Deer	8
Deer hide	1
Deer meat, pounds	1,868
Dove	16
Ducks	111
Elk	1
Goose	5
Grebe	1
Hawks	2
Killdeer	3
Lesser scaup	1
Mallard Hen	1
Marbled Godwit	1
Meadow larks	2
Mockingbird	1
Mudhens	14
Pheasant	12
Quail	23
Rabbits	13
Robins	6
Seagulls	1
Sea scoter	1
Sparrow, white-throated	2
Squirrels	2
Squirrel skins	4
Surf scoters	2
Swan	1
Venison ham	1

Fish:

Abalones	273
Abalones, pounds	20
Barracuda, pounds	2,140
Bluegills	3
Catfish, pounds	41
Clams	1,883
Clam forks	3
Clams, quarts	1
Cockles, pounds	350
Crabs	3,336
Crab traps, boxes	46
Eastern brook trout	41
Lobsters	117
Lobster traps	54
Mackinaw trout	1
Pyramid Lake trout	12
Rainbow trout	116
Salmon, pounds	25
Set lines, feet	300
Steelhead	107
Steelhead, pounds	280
Trout	23
Yellowfin tuna, pounds	10,586

GAME CASES

January, February, March, 1938

Offense	Number arrests	Fines imposed	Jail sentences (days)
Beaver; no license	2	\$50 00	30
Birds; possession in violation of Fish and Game Code	1		
Brant; take	2		
Deer; possession spike buck, closed season, possession venison, possession parts of female, possession does and fawns, transporting into closed district, tags not validated, failure to produce hide and horns, illegal possession deer meat, killing spike buck, killing doe, possession deer, evidence of sex removed	88	2,513 00	1,983
Doves; closed season	7	140 00	
Discharging firearms in a fowl refuge	2		
Ducks, possession closed season, overlimit, early shooting, kill and possess wild ducks, possess surf scoter closed season	16	195 00	237
Firearms; possession in refuge	5	25 00	
Fur bearing mammals; take for profit, no license	1		
Game; possession of ten days after close of season	1	25 00	
Game birds; closed season, shooting from auto, sell, trade, barter wild game birds, no license	8	70 00	10
Geese; shooting after 4 p.m., kill closed season	3	60 00	
Hunting; no license	21	260 00	180
Mudhens; possession, kill closed season, take after 4 p.m.	5	25 00	
Mink; trapping out of season	1	10 00	
Night hunting	5	45 00	10
Non-game birds; hunting, shoot; take grebe, robins, meadowlark	21	295 00	100
Pheasants; closed season, no license, kill hen, possession male	19	835 00	215
Protected birds, no license, marbled godwit	2	35 00	
Quail; possession overlimit, closed season, possession valley quail	7	135 00	
Rabbits, no license, closed season, cottontail and brush, closed season	20	227 00	10
Seagull; killing, possession	1	25 00	
Shorebirds; possession killdeer	8	100 00	
Squirrels; grey squirrel skins, possession tree squirrel, grey squirrel	3	20 00	37½
Shooting after 4 p.m.; migratory waterfowl	5	115 00	
Swan, possession wild	1	25 00	
Trapping, no license	2		
Waterfowl, take between 4 p.m. and 7 a.m.	2	40 00	
Wood ducks, possession of	1	12 50	
	260	\$5,282 50	2,812½

FISH CASES

January, February, March, 1938

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; using diving apparatus to take, possession undersized, bring ashore out of shells, undersized red, overlimit, undersized green, closed season, undersized black, no license, sliced abalones, take in marine refuge, no permit, possession black abalones less than five inches	41	\$480 00	20
Angling; no license, closed stream, closed tributaries to Russian River, closed territory	20	195 00	65
Barracuda; possession and sell undersized	1		
Bass; fishing for striped no license, take striped by other than hook and line, overlimit	6	10 00	
Bluegills; closed season	1	25 00	
Catfish; retaining less than nine inches in length, sale of, undersized	2	40 00	
Clams; undersized pismo, possession in clam refuge, overlimit pismo, no license, take pismo clams in clam preserve	57	780 50	400½
Cockles; more than six dozen in possession, possession undersized	6	85 00	10
Commercial fishing; no license	39	530 00	12½
Crabs; taking undersized, possession undersized; take from Dist. 1½ to 2, take female crabs	34	345 00	641
Dynamite; placing in State waters to take fish	1	100 00	
Failure to show license on demand	8		
Fish spear; possession within 300 feet of stream	4		
Frogs; possession undersized	1	25 00	
Gaff; possession within 300 feet of stream	1		
Game fish; no license	2	10 00	
Gill net in Dist. 2, in Old River, meshes less than 5½-inch in length	2	25 00	
Lobsters; possession undersized; possession spiny lobsters less than 10½ inches	3	25 00	12½
Net; operating in Dist. 1	1	25 00	
Operating set lines in White Slough, in Taylor Slough, Middle River, Honker Bay, District 1	11	430 00	
Perch; possession closed season	2	30 00	
Pollution	23	2,055 00	
Roundhaul net in District 19-A	6	100 00	
Seining in District 20	4	1,200 00	
Spear in possession in creek	3	75 00	
Steelhead; illegally taken, overlimit, spearing in Santa Ynez River, gaffing, closed season, no license, selling	8	125 00	1
Taking with set lines; crappie, perch, sunfish at night	1	25 00	
Trout; taking during closed season, no license, unlawful possession closed season, more than daily bag limit, overlimit	11	167 00	30
Yellowfin tuna, sale undersized	1	500 00	
Totals	300	\$7,407 50	1,192½

CHANGE IN PRESENTATION OF FISHERIES STATISTICS

To meet changing conditions, the former quarterly tables of landings of commercial fish in California which have appeared in *California Fish and Game* for a number of years, have been supplanted by monthly tables. Although this new monthly record covers the same material, the figures will not be entirely comparable with the former quarterly tables. The change has been made with the idea of simplifying and improving the usefulness of the records presented. The major differences are therefore outlined and the reasons for each change are given.

1. Quarterly tables were formerly published chiefly because the magazine was issued quarterly. It is the consensus of opinion that monthly records will be far more useful.

2. With the cessation of commercial salmon fishing in the rivers of the northern part of the State, there was eliminated the need for keeping the Del Norte and Eureka records separated. In the new tables these two regions have been combined.

3. The new heading of the table, "Fresh Fish Landings of California Boats", means exactly that. The table now represents the catch of the California fishing fleet without the confusing inclusion of importations from other states and foreign countries. The record of species landed in Los Angeles and San Diego regions from south of the international boundary represents the catch of California boats, manned by California fishermen. In some cases these boats go as far south as the equator and either return to their home port with the catch or transfer it to a tender to be delivered to the canneries and fresh fish markets in California. There is one possible exception in the record of spiny lobsters. On the west coast of Lower California the lobster camps are financed and outfitted in California, their supplies and even the drinking water are carried from California. Natives in skiffs attend the lobster traps, but the catch is delivered to a tender which takes the supplies to the camp and returns to California ports with the catch. For the purpose of this record this lobster catch was included with the take of California fishermen.

4. In the former quarterly tables, the poundage was credited to the place where the business was transacted. This was misleading in the case of the trawler catch, a large portion of which is landed half the length of the State away from its final destination, the business headquarters. In the new monthly tables we are endeavoring to rectify this and credit the trawler fish to the region in which it is first landed.

5. The importation tables have been divided into two types: one, a record of the fish delivered from other states and foreign countries to the California canneries for packing; and the second, the voluntary record of importations to the fresh fish markets for sale in competition with the catch of California fishermen.

Formerly these importations were included in the total landing tables for California, and a separate table was given, which showed these importations combined with the catch of California fishermen beyond the State boundaries.

The table of importations for canning is complete and records such items as fish taken by fishermen in the states to the north and shipped to our canneries, as well as fish caught in Japan, frozen and delivered by ocean liner for packing in California.

The importations for the fresh fish markets are far from complete and for this reason should be treated separately. Formerly the figures were included in the landing table. These have been eliminated because they were misleading.—*Geraldine Conner, Fisheries Statistician, California State Fisheries Laboratory, June 15, 1938.*

**FRESH FISH IMPORTATIONS FROM OTHER STATES AND FOREIGN COUNTRIES
JANUARY, 1938**

	Oregon	Gulf of California	Japan
For canneries:			
Tuna, Albacore.....	7,207		
For fresh fish markets:*			
Corbina, Mexican.....		8,587	
Sea-bass, Totuava.....		392,306	
Crustacean:			
Shrimp.....		1,425	
Total pounds.....	7,207	402,318	

FEBRUARY, 1938

	Oregon	Gulf of California	Japan
For canneries:			
Tuna, Albacore.....	26,624		
Tuna, Skipjack.....			106,362
For fresh fish markets:*			
Corbina, Mexican.....		11,921	
Sea-bass, Totuava.....		659,265	
Crustacean:			
Shrimp.....		225	
Total pounds.....	26,624	671,411	106,362

MARCH, 1938

	Oregon	Gulf of California	Japan
For canneries:			
Tuna, Skipjack.....			66,939
For fresh fish markets:*			
Barracuda.....		316	
Cabrilla.....		2,673	
Corbina, Mexican.....		22,604	
Sea-bass, Black.....		177	
Sea-bass, Totuava.....		538,349	
Total pounds.....		564,119	66,939

* This record includes only that fish which is voluntarily reported to the Division of Fish and Game and does not represent all importations.

Tuna, Bluefin.....	141																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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* The eight geographical regions of the State are as follows:

- Regions 10 and 20. Del Norte and Eureka. Del Norte, Humboldt and Mendocino Counties.
 Region 30. Sacramento. The Sacramento and San Joaquin river systems with the delta areas, including Suisun Bay and Lake County.
 Region 40. San Francisco. Sonoma, Marin, San Francisco and San Mateo Counties, including San Francisco Bay points.
 Region 50. Monterey, Santa Cruz and Monterey Counties.
 Region 60. San Luis Obispo, Ventura and Santa Barbara Counties.
 Region 70. Los Angeles, Los Angeles and Orange Counties.
 Region 80. San Diego, San Diego and Imperial Counties.
 These tables subject to slight revision due to belated supplemental items.

FRESH FISH LANDINGS OF CALIFORNIA BOATS, FEBRUARY, 1938
 Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters							Waters south International boundary		Total • landings of (California boats
	Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Region 70, Los Angeles	Region 80, San Diego	
Anchovy.....						2,902	148	2,902		2,902
Barraouda.....						3,270		3,418	122,023	37,596
Cabezone.....	51			85				136		136
Gabrilla.....		1,441						1,441	7,251	7,548
Carp.....		8,835						8,835		8,835
Catfish.....	21,069		11,413	3,136				33,618		35,618
Flounder, Starry	1,013		26,419	388				27,820		27,820
Grouper.....									1,019	1,149
Hake.....		2,900						2,900		2,900
Halibut, California		1,257		4,058	22,018	39,282	45,645	112,260	33	222
Hardhead.....		625						625		625
Herring, Pacific	25		149,961	397		32,444		150,383		150,383
Kingfish.....				4,605	59	677,765		37,108		37,108
Mackerel, Horse				2,965		2,287,758	20	680,730		680,730
Mackerel, Pacific				99,376	126			2,387,280	1,792	2,387,280
Mackerel, Spanish										1,792
Perch.....	602		9,894	1,333	10	7,966		19,805		19,805
Pike.....		114						114		114
Pompano, California						163		163		163
Rock Bass.....						2,525	400	12,800	989	2,182
Rockfish.....	13,396		51,679	186,842	32,351	26,322	845	311,435		322,826
Sablefish.....	1,086			90	10	23,547		24,733		24,733
Salmon.....		1,017	878					1,895		1,895
Sand Dab.....			62,392	91		561		63,044		63,044
Sardine.....			55,671	2,097,643		52,440,068	214,915	54,808,297		54,808,297
Sculpin.....					291	5,719	350	6,360		6,360
Sea-bass, Black					1,833	56	216	3,356	12,956	22,298
Sea-bass, White					1,560	2,419	2,103	6,211	1,526	22,333
Sea-trout, California	330			129				330		330
Shark.....	248	188,604	132,659	37,597	31,058	7,831	4,282	402,279		402,279
Sheepshead.....					1,448	2,051	133	3,632		5,566
Skate.....			61,168	12,224	3,456	1,093		77,941		77,941
Smelt.....	105		25,003	781	1,236	15,401		42,526		42,538
Sole.....	884		451,103	18,837	10,877	10,446		482,147		482,147
Split-tail.....								1,974		1,974

[illegible]

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BUREAU OF HYDRAULICS

JOHN SPENCER, Chief.....	San Francisco
Clarence Elliger, Assistant Hydraulic Engineer.....	San Francisco
Byron Wittorff, Assistant.....	San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief.....	Sacramento
J. J. Shannon, License Agent.....	Sacramento
L. O'Leary, License Agent.....	San Francisco
R. Nickerson, License Agent.....	Los Angeles

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol.....	San Francisco
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CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge.....	Sacramento
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Northern Division

Jos. H. Sanders, Captain in Charge.....	Sacramento
Don Chipman, Warden, Flying Squad.....	Redding
Eugene Durney, Assistant Warden, Flying Squad.....	Sacramento
A. H. Willard, Captain.....	Nevada City
A. A. Jordan, Captain.....	Redding
Chas. Sibeck, Warden, Launch "Rainbow".....	Sacramento
Otis Wright, Assistant Warden, Launch "Rainbow".....	Sacramento
J. E. Hughes, Warden, Modoc County.....	Alturas
Brice Hammack, Warden, Siskiyou County.....	Yreka
Fred R. Starr, Warden, Siskiyou County.....	Dorris
C. L. Gourley, Warden, Trinity County.....	Weaverville
Earl Caldwell, Warden, Shasta County.....	Burney
Chas. Love, Warden, Shasta County.....	Redding
C. O. Fisher, Warden, Lassen County.....	Susanville
W. C. Blewett, Warden, Plumas County.....	Quincy
R. W. Anderson, Warden, Tehama County.....	Red Bluff
E. C. Vail, Warden, Glenn County.....	Willows
L. E. Mercer, Warden, Butte County.....	Chico
A. Granstrom, Warden, Sierra County.....	Downieville
Earl Hiscox, Warden, Nevada County.....	Nevada City
Wm. La Marr, Warden, Nevada County.....	Nevada City
R. A. Tinnin, Warden, Yuba County.....	Browns Valley
L. W. Dinsdale, Warden, Sutter County.....	Yuba City
Taylor London, Warden, Colusa County.....	Colusa
R. L. Sinkey, Warden, Yolo County.....	Woodland
W. J. Black, Warden, Solano County.....	Suisun
H. S. Vary, Warden, Sacramento County.....	Sacramento
Nelson Poole, Warden, Placer County.....	Auburn
Albert Sears, Warden, El Dorado County.....	Placerville

Southern Division

S. R. Gilloon, Captain in Charge.....	Fresno
John O'Connell, Captain.....	Stockton
E. O. Wraith, Captain.....	Bakersfield
Wm. Hoppe, Warden, San Joaquin County.....	Lodi
J. W. Thornburg, Warden, San Joaquin County.....	Tracy
R. J. Little, Warden, Amador County.....	Jackson
L. R. Garrett, Warden, Calaveras County.....	Murphys
F. F. Johnston, Warden, Tuolumne County.....	Sonora
Geo. Magladry, Warden, Stanislaus County.....	Modesto
M. S. Clark, Warden, Merced County.....	Merced
C. S. Donham, Warden, Merced County.....	Gustine
Ray Ellis, Warden, Kings County.....	Hanford
Gilbert T. Davis, Warden, Mariposa County.....	Mariposa
H. E. Black, Warden, Madera County.....	Madera
Paul Kehrner, Warden, Fresno County.....	Fresno
F. A. Bullard, Warden, Fresno County.....	Reedley
R. J. Bullard, Warden, Tulare County.....	Porterville
W. I. Long, Warden, Tulare County.....	Visalia
Lester Arnold, Warden, Kern County.....	Bakersfield
Roswell Welch, Warden, Kern County.....	Kernville

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge.....	San Francisco
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Northern Division

W. J. Harp, Captain in Charge	Ukiah
R. E. Tutt, Warden, Flying Squad	Willits
R. Remley, Warden, Flying Squad	Willits
J. D. Dondero, Captain	Eureka
Henry Lencioni, Captain	Santa Rosa
John Hurley, Warden, Humboldt County	Eureka
W. F. Kaliher, Warden, Humboldt County	Fortuna
Ovid Holmes, Warden, Mendocino County	Fort Bragg
Leo Mitchell, Warden, Mendocino County	Point Arena
E. J. Johnson, Warden, Lake County	Lakeport
J. H. Groves, Warden, Sonoma County	Cloverdale
Victor Von Arx, Warden, Sonoma County	Santa Rosa
Bert Laws, Warden, Sonoma County	Petaluma
J. W. Harbuck, Warden, Napa County	Napa
R. J. Yates, Warden, Marin County	San Rafael
Scott Feland, Warden, Del Norte County	Crescent City

Southern Division

Wm. Lippincott, Captain in Charge	San Francisco
Owen Mello, Warden, Flying Squad	San Jose
O. P. Brownlow, Captain	Alameda
Ed Clements, Warden, Contra Costa County	Salinas
C. L. Bundock, Warden, Alameda County	Martinez
C. E. Holladay, Warden, Santa Clara County	Oakland
Lee C. Shea, Warden, San Francisco County	San Jose
C. R. Peek, Warden, San Mateo County	San Francisco
F. J. McDermott, Warden, Santa Cruz County	San Mateo
J. P. Vissiere, Warden, San Benito County	Santa Cruz
F. H. Post, Warden, Monterey County	San Juan Bautista
Orben Philbrick, Warden, Monterey County	Salinas
F. W. Hecker, Warden, San Luis Obispo County	Kirg City
	San Luis Obispo

Marine Fisheries Detail (Coast District)

Ralph Classic, Captain	Monterey
L. J. Weseth, Master, M. V. "Albacore"	San Francisco
Kenneth Hooker, Warden, Cruiser "Quinnat III"	San Francisco
Nathan Rogan, Assistant Warden, Cruiser "Quinnat III"	San Francisco
Leslie E. Lahr, Warden	Eureka
G. R. Smalley, Warden	Richmond
Ralph Miller, Warden	San Francisco
Charles Holzhouser, Warden	Watsonville
Charles Mayfield, Warden	Monterey
C. Apsley, Assistant Warden, Launch "Sturgeon"	Martinez
J. A. Oneto, Assistant Warden, Launch "Sturgeon"	Martinez

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge	Los Angeles
E. H. Ober, Captain Special Duty	Los Angeles

Western Division

L. F. Chappell, Captain in Charge	Los Angeles
Theo. Jolley, Warden, Flying Squad	Los Angeles
Walter Shannon, Warden, Flying Squad	Los Angeles
L. T. Ward, Captain	Escondido
Earl Macklin, Captain	Santa Barbara
A. R. Ainsworth, Warden, Santa Barbara County	Santa Maria
R. E. Bedwell, Warden, Santa Barbara County	Santa Barbara
G. N. Johnson, Warden, Ventura County	Ventura
Fred Albrecht, Warden, Los Angeles County	Los Angeles
James Loundagin, Warden, Imperial County	Brawley
W. L. Hare, Warden, Los Angeles County	San Fernando
Walter Emerick, Warden, Orange County	Santa Ana
E. H. Glidden, Warden, San Diego County	San Diego

Eastern Division

H. C. Jackson, Captain in Charge	San Bernardino
Ray Diamond, Warden, Flying Squad	San Bernardino
A. L. Stager, Warden, Flying Squad	San Bernardino
Captain	Bishop
Al Crocker, Warden, Mono County	Banning
C. J. Walters, Warden, Inyo County	Bridgeport
E. L. Walker, Warden, Inyo County	Independence
W. C. Malone, Warden, San Bernardino County	Bishop
W. S. Talbott, Warden, San Bernardino County	San Bernardino
J. H. Gyger, Warden, Riverside County	Pine Knot
R. C. O'Conner, Warden, Riverside County	Perris
	Banning

Marine Fisheries Detail (Southern District)

C. H. Groat, Captain in Charge	Terminal Island
Walter Engelke, Master, M. V. "Bluefin"	Terminal Island
E. R. Hyde, Warden, Cruiser "Yellowtail"	Balboa
Niles Millen, Assistant Warden, Cruiser "Yellowtail"	Balboa
Robt. Cowell, Warden, Cruiser "Marlin"	San Diego
W. E. Scrimsher, Assistant Warden, Cruiser "Marlin"	San Diego
Carmi Savage, Warden, Cruiser "Tuna"	Avalon
Karl Lund, Assistant Warden, Cruiser "Tuna"	Avalon
Howard V. Shebley, Warden, Cruiser "Bonito"	Santa Barbara
Assistant Warden, Cruiser "Bonito"	Santa Barbara
John Spicer, Warden, Cruiser "Broadbill"	Santa Monica
R. L. Metzgar, Assistant Warden, Cruiser "Broadbill"	Santa Monica
N. C. Kunkel, Warden	Terminal Island
E. A. Chan, Warden	Terminal Island
L. G. Van Vorhis, Warden	Terminal Island
Erol Greenleaf, Warden	Terminal Island
Tate F. Miller, Warden	Terminal Island
Donald Glass, Warden	Terminal Island
T. J. Smith, Warden	San Diego
Lester Golden, Warden	Arroyo Grande

POLLUTION DETAIL

Paul Shaw, Chemist in Charge	San Francisco
C. L. Towers, Warden	Los Angeles
John McKerlie, Warden	Oakland
Don Davison, Warden	Sacramento
R. Schoen, Warden	Los Angeles
E. A. Johnson, Assistant Warden	Terminal Island

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol	San Francisco
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MARINE PATROL

Motor Vessel "Bluefin,"	Terminal Island
Motor Vessel "Albacore,"	Monterey
Cruiser "Yellowtail,"	Newport Harbor
Cruiser "Broadbill,"	Santa Monica
Cruiser "Quinnat III,"	San Francisco
Cruiser "Bonito,"	Santa Barbara
Cruiser "Marlin,"	San Diego
Cruiser "Tuna,"	Avalon
Launch "Rainbow,"	Sacramento
Launch "Shrapnel,"	Lakeport
Launch "Silver-side,"	Eureka
Launch "Sturgeon,"	Martinez